

PROCEEDINGS

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III

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1913, pp. 1-337,

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PROCEEDINGS
OF THE
GENERAL MEETINGS FOR SCIENTIFIC BUSINESS
OF THE
ZOOLOGICAL SOCIETY
OF LONDON.

1913.

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PROCEEDINGS

OF THE

GENERAL MEETINGS FOR SCIENTIFIC BUSINESS

OF THE

ZOOLOGICAL SOCIETY OF LONDON.

EXHIBITIONS AND NOTICES.

November 12, 1912.

Dr. A. SMITH WOODWARD, F.R.S., Vice-President,
in the Chair.

The SECRETARY read the following report on the Additions that had been made to the Society's Menagerie during the month of October, 1912.

The registered additions to the Society's Menagerie during the month of October were 259 in number. Of these, 120 were acquired by presentation, 64 by purchase, 31 were received on deposit, 33 in exchange, and 11 were born in the Gardens.

The number of departures during the same period, by death and removals, was 262.

Amongst the additions special attention may be directed to:—

1 African Buffalo (*Bubalus caffer*) ♀, from the Sezibwa Swamp, Uganda, presented by H. M. Birch, Esq., on October 22nd.

1 Fossa (*Cryptoprocta ferox*) ♂, from Madagascar, purchased on October 23rd.

1 Pampas Cat (*Felis pajeros*), 1 Pampas Cavy (*Cavia rufescens*), 3 Pampas Gerbilles (*Reithrodon typicus*), 2 Pampas Field-Mice (*Akodon arenicola*), 1 Argentine Mocking-Bird (*Mimus modulator*), and 3 Pelzeln's Saffron-Finches (*Sicalis pelzelni*), from Argentina, the five last-named new to the Collection, presented by Wilfred A. Smithers, Esq., on October 16th.

1 Black-headed Hangnest (*Icterus melanocephalus*), from Mexico, new to the Collection, presented by W. O. Danckwerts, Esq., K.C., F.Z.S., on October 10th.

2 Great-billed Ravens (*Corvultur crassirostris*), from N.E. Africa, new to the Collection, presented by the Marquess of Tavistock, F.Z.S., on October 3rd.

1 Yellow-fronted Barbet (*Cyanops flavifrons*), from Ceylon, new to the Collection, purchased on October 17th.

2 Orange-bellied Fruit-Pigeons (*Ptilopus iozonus*), 2 Pearl-spotted Fruit-Pigeons (*Ptilopus zonurus*), 1 Wallace's Fruit-Pigeon (*Ptilopus wallacei*), and 1 Yellow-bellied Ground-Pigeon (*Phlogænas helviventris*), from the Aru Islands, all new to the Collection, purchased on October 15th.

4 White-throated Tree-Partridges (*Arboricola crudigularis*), from Formosa, new to the Collection, received on deposit on October 23rd.

3 Leith's Snakes (*Psammophis leithii*), from S.W. Asia, new to the Collection, purchased on October 15th.

The SECRETARY exhibited a photograph of the Hainan Gibbon (*Hylobates hainanus*) in natural colours, taken by Messrs. Elliott & Fry, by the Lumière process.

Mr. G. A. BOULENGER, F.R.S., F.Z.S., exhibited a specimen, 155 mm. long, of the African Cichlid Perch (*Hemichromis bimaculatus* Gill), which had recently died in Capt. Vipan's aquarium. The specimen was remarkable for its large size. Although the species is common over a considerable part of Africa, and hundreds of specimens have been collected in various localities, no wild example is known to exceed a length of 100 mm.

This *Hemichromis* is tinged with bright red about the head and on the fins, and, as was noticed in the 'Fishes of the Nile,' p. 462, this red is soluble in spirit, which, a few hours after the immersion of the fish, acquires a bright orange-red colour.

Mr. EDWARD GERRARD exhibited the skull of an Indian Rhinoceros (*Rhinoceros unicornis*) which had recently died in the Society's Gardens. He pointed out that abscesses had been formed at the base of the lower incisors, which had been much rubbed down so that the nerves had become exposed. The animal must have suffered great pain, and this no doubt was the cause of his dashing his head against the walls and bars of his den in the violent manner he at times did.

Mr. E. G. BOULENGER, F.Z.S., Curator of Reptiles, exhibited a living specimen of the Salamander, *Amblystoma tigrinum*, which

P. Z. S. 1913. Pl. TX.



NEST MADE BY ORANG-UTAN.

Photo. D. Seth-Smith.

he had obtained from an Axolotl placed in special conditions with the object of inducing the metamorphosis.

Mr. D. SETH-SMITH, F.Z.S., Curator of Birds, gave a lantern demonstration of photographs of the young of Hemprich's Gull (*Larus hemprichi*), of the Black-necked Swan (*Cygnus melanocoryphus*), and of the White Stork (*Ciconia alba*) which had been hatched in the Society's Gardens during the year.

Three specimens of *Larus hemprichi* had lived in the Gardens since 1906, but had shown no inclination to breed until the summer of 1912. In July a pair kept in the Great Aviary constructed a nest, composed of a few bits of grass and leaves under a bush, laying two eggs of a pale greenish-grey colour, spotted and blotched with bluish grey and olive-brown. As there were birds in the aviary which would have devoured the young, the eggs were taken when just about to hatch and placed under a bantam. Both hatched, but one died on leaving the shell. The other was successfully raised to maturity. The colour of the down was pale sandy-whitish, without any definite markings, though the back was of a darker shade than the underparts. In the first plumage it was of a buffish-brown colour, the feathers having paler edges.

The Black-necked Swan had not bred in the Gardens for over thirty years until the past summer, when two cygnets were hatched, one of which was successfully reared to maturity. The cygnets, which are pure white in colour when hatched, have a second down plumage of a dirty buffish-brown colour.

The White Storks, kept in the large flying aviary with the Seagulls, had hatched five young birds, which unfortunately died when from two to three weeks old.

Mr. Seth-Smith also showed slides of the nest, in a tree near the Apes' House, made by the large Sumatran Orang-utan (*Simia satyrus*) which escaped from its cage on November 3rd, 1912 (Plate IX.). Mr. R. I. Pocock gave an account of the escape and subsequent capture of the Orang-utan.

November 26, 1912.

Dr. A. SMITH WOODWARD, F.R.S., Vice-President,
in the Chair.

Mr. C. TATE REGAN, M.A., F.Z.S., exhibited male and female examples of *Cynolebias bellottii*, a Cyprinodont Fish from the La Plata, to illustrate the remarkable sexual characters.

Mr. OLDFIELD THOMAS, F.R.S., F.Z.S., exhibited a specimen of an Amazonian monkey referable to a species he had described in

1904, from an example without a skull, as *Midas goeldii*, but which had recently been redescribed by Dr. Ribeiro, from the living animal, as *Callimico snethlageri*, a new genus and species "intermediate between *Callicebus* and *Mico*."

Mr. Thomas's examination of Dr. Ribeiro's type specimen, sent over by the authorities of the Para Museum, showed that *Callimico* really was intermediate between the Cebidæ and Callitrichidae, having the external characters of a Marmoset, notably the elongated claws, combined with the shape of skull and molar formula of the Cebidæ. The molars themselves possessed no hypocone, as in the Marmosets.

The animal being, therefore, intermediate in character between the two families Cebidæ and Callitrichidae, there was great difficulty in deciding as to the effect its discovery should have on the systematic arrangement of the American Monkeys, and as to whether these two families ought still to be kept separate.

On the whole, as causing least disturbance, Mr. Thomas thought that the best plan would be to form a special subfamily, the Callimiconinæ, for *Callimico*, and to include this as a second subfamily with the Cebinæ in the family Cebidæ. But that *Callimico* was a real genetic link between the two families there seemed to be no doubt whatever.

PAPERS.

1. Contributions to the Anatomy and Systematic Arrangement of the Cestoidea. By FRANK E. BEDDARD, D.Sc., M.A., F.R.S., F.Z.S., Prosector to the Society.

[Received September 27, 1912 : Read October 29, 1912.]

(Text-figures 1-10.)

VII. ON SIX SPECIES OF TAPEWORMS FROM REPTILES, BELONGING TO THE GENUS *ICHTHYOTÆNIA* (*s. l.*).

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The genus *Ichthyotænia* (whose possible subdivisions I discuss later) is chiefly found among freshwater fishes—that is, most of

the species infest those vertebrates. Two species, however, viz. *I. schultzei** and *I. lönnbergi*†, have been met with in amphibians—the former in *Rana adspersa*, the latter in *Necturus*. The other members of the genus are known to inhabit reptiles, both snakes and lizards, and, if we allow *Tetrabothrium trionychium* ‡ to be of this genus, tortoises.

§ *Some Species of Ichthyotenia (Acanthotenia) from Monitor Lizards.*

Our knowledge of the parasites of Monitor Lizards is obviously not very extensive at present, for very few species of these lizards have been examined or at any rate have yielded parasites. These have been referred to five genera, viz. *Duthiersia*, *Scyphocephalus* (both of which are Bothrioccephalids), *Pancerina*, *Palaia*, and *Ichthyotenia* (including *Acanthotenia*). With the two first-named genera I do not concern myself in the present communication. The name *Acanthotenia*, whether necessary or not, was apparently given by v. Linstow under a misconception of the structure of the worm of which he gave an account under the name of “*Acanthotenia shipleyi*, nov. gen. et sp.” §. In my opinion it was probably by reason of having not seen the peripherally situate vitelline glands, and of having wrongly termed the ovaries vitelline glands, that v. Linstow created the genus, rather than by virtue of the densely-set spinelets upon the scolex, though the latter clearly suggested the name. Two worms from another species of *Varanus* had been previously (in 1900) described by v. Ratz || as members of the genus *Ichthyotenia*; and this name is retained by Schwarz ¶, who, however, was apparently unacquainted with v. Linstow's paper, which is not quoted in his list of literature. Finally, at about the same time as Schwarz, T. H. Johnston ** described under the name of *Acanthotenia* a fourth species from *Varanus varius*. So far as I am aware, this exhausts the species of *Ichthyotenia* which have been recorded from lizards of the genus *Varanus*.

It appears to me to be probable that *Palaia varuni*, a new species and genus described by Dr. Shipley †† from *Varanus indicus*, is also to be referred to this genus *Ichthyotenia*. It is true that Johnston, in his memoir upon *Ichthyotenia (Acanthotenia) tidswelli*, is not of that opinion; there are, however, certain reasons which seem to be favourable to its inclusion within the present genus.

* Hungerbühler, Jen. Denkschr. 1910.

† Fuhrmann, “Die Tænien der Amphibien,” Zool. Jahrb. ix. Anat. 1896.

‡ Löömborg, “Ueber eine neue Tetrabothriumspecies, &c.,” Centralbl. Bakt. u. Paras. xv. 1894.

§ Centralbl. Bakt. u. Paras. xxxiii. 1903, p. 534.

|| Centralbl. Bakt. u. Paras. 1900; C. R. Soc. Biol. 1900; Arch. de Paras. iv. 1900.

¶ “Die Ichthyoteniæ der Reptiliæ, &c.,” Inaug.-Diss., Univ. Basel, 1908. For a copy of this I am greatly indebted to the author.

** “On a new Reptilian Cestode,” Proc. Roy. Soc. N.S. W. vol. xlvi. 1909, p. 103.

†† Description of Entozoa &c. in Willey's ‘Zoological Results,’ Cambridge, 1900.

It must be remembered that when Dr. Shipley described *Palaia varani* the genus *Ichthyotænia* had not actually been described from *Varanus*, since Ratz's memoirs appeared contemporaneously with that of Dr. Shipley. Dr. Shipley himself thought that *Palaia* came nearest to *Oochoristica*, a genus which also occurs in reptiles. He did not consider *Panceria*, to which I shall refer immediately in this connection.

The reasons which lead me to regard *Palaia varani* as a species of *Ichthyotænia* are largely negative, but there are also one or two positive facts. Firstly, the only Tænid parasites of *Varanus* are *Ichthyotænia* and *Pancerina*, and as to the former it is now known that four species of *Varanus* harbour different species of *Ichthyotænia*. This is not obviously conclusive against the occurrence of another genus; but it may be borne in mind as something of an argument. The general structure of *Palaia* is not in the least opposed to its inclusion in the genus *Ichthyotænia*. It is of course true that the same characters would fit other genera, and unfortunately the reproductive system could not be described in any detail. The author gives a figure of a transverse section of the worm, whence it would appear that the transverse muscular layer lies in the medullary parenchyma, as has been described by Schwarz in his memoir referred to on this genus *Ichthyotænia*. The most important positive reason for the inclusion of *Palaia varani* in the genus *Ichthyotænia* is in the character of the eggs, which are particularly described and figured as lying in clumps, the individual eggs being adherent. This is highly characteristic of the reptilian members of the genus, and I have something in the present paper to say upon the matter.

The genus *Pancerina* (originally described under the pre-occupied name of *Panceria*) occurs in *Varanus arenarius*, whence it has been described by Sonsino * and Stossich †, more fully by the former of these two authorities. *Pancerina* is placed by systematists ‡ in the neighbourhood of *Oochoristica*, to which Dr. Shipley thought that *Palaia* was allied. The double reproductive organs in each proglottid prevent any confusion between this genus and *Ichthyotænia*. Nevertheless there do not appear to me to be any positive facts which forbid the near relationship of *Pancerina* and *Ichthyotænia*, there being no definite statement by Sonsino as to the vitelline gland.

In two specimens of *Varanus niloticus* a series of small tape-worms was found which clearly belong to this genus *Ichthyotænia*. I am inclined to think that the worms from one specimen of this *Varanus* are different from those found in another specimen of the lizard. But inasmuch as the worms of one series were not mature, I am not able to speak with certainty as to some necessary specific characters. Moreover, I had the opportunity of examining one series in the living condition, and am not therefore able to report

* Monit. Zool. Ital. vi. 1895, pp. 121 & 189.

† Boll. Soc. Adr. Trieste, xvi. 1895, p. 42. Described as *Tænia varani*.

‡ E. g., Ransom, Bull. U.S. Nat. Mus. no. 69, 1909.

certain characters as obvious in the living tapeworm which could not be detected in the alcohol-preserved examples from the other lizard. In the meantime I furnish a separate description of the two series of tapeworms.

The immature worms are distinctly smaller than the others, which is again in favour of regarding them as different species. It is interesting to note that in *Varanus niloticus*, as in *Varanus varius* (as will be pointed out later), a small and a comparatively large species of *Ichthyotænia* occur together. But it must be borne in mind that in the case of *Varanus niloticus* they did not infect the same individual.

These worms are indeed quite small, measuring not more than from 10 to 15 mm. They present quite the appearance of a fine white thread, as in the case of *Ichthyotænia tidswelli* and of one of the species which I describe in the present paper from *Varanus varius*. I have studied them entire and in transverse and sagittal sections; but owing to their immaturity my description has many lacunæ, in consequence of which I do not propose to give a name to the species. The most striking external character is one that I have not met with in any other tapeworm. The base of the scolex and a certain amount of the ensuing strobila was tinged of a bright carmine, which I thought at first was merely a blood-stain. It is not, however, blood-colour by reflected or transmitted light, and is distinctly bright pink. Moreover it resisted for a certain period the action of alcohol, but was ultimately washed out. This pigment does not occur in the form of granules, like the black pigment which is not rare in the heads of tapeworms. It is diffused through the tissues, though I am not able to delimit the regions where it occurs. It is highly characteristic and quite unmistakable. Nothing of the kind appears to be mentioned by Johnston in *Ichthyotænia (Acanthotænia) tidswelli*.

The scolex of this worm is very mobile, and the anterior end (the rostellar region) can be protruded far or flattened down or actually retracted, thus producing an apical and conical cavity which might be mistaken for a sucker-like structure in an individual which had been fixed in death in this position. As the majority of tapeworms are always described from preserved examples, it is worth while to dwell upon this great flexibility of movement; and, moreover, Rigganbach has used the presence of an apical dimple as an aid to the systematic arrangement of the genus *Ichthyotænia**. Among the preserved examples which I also studied during life I find some with fully expanded and others with retracted rostellum. This species is at least to be contrasted in this respect with that described by Johnston, in which the author particularly states that the rostellum is represented by a muscular plug which is not retractile. In the same way the four suckers are very mobile and can be protruded in the shape of finger-like processes. There are, of course, no hooks

* Rev. Zool. Suisse, iv. 1896, p. 165.

upon the scolex; but there is a fine investment of minute spinelets, which are most densely set but are absent from the apex of the scolex. The suckers seem to look upward when in a state of rest.

Text-fig. 1.



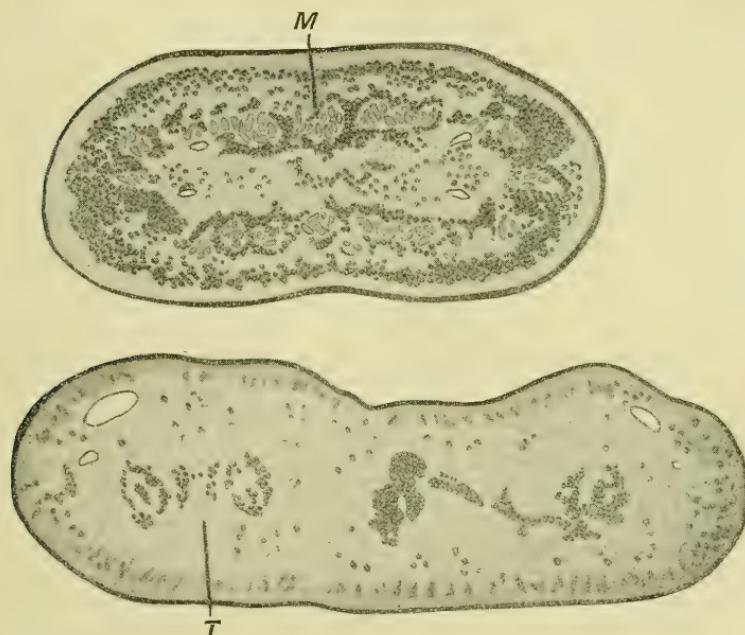
Two sections through the scolex of *Ichthyotenia (Acanthotenia) sp.*

The upper figure displays the partial protrusion of the rudimentary rostellum (R) permitted (R) by the absence of external spinelets in this region as shown in the figure. The lower figure passes through a sucker (S), and here the covering of spinelets is seen to extend into the interior of the sucker.

Transverse sections through the scolex (see text-fig. 1) show an anteriorly situated muscular organ comparable with a rostellum. It is rudimentary, and not like that which I describe below as characteristic of the second species of tapeworm from this *Varanus*. The suckers are borne at the base of the apical cone, and the actual suckers are on processes of the body, and not sessile upon

it, as they have been figured in some other species. Between the layer of muscles which forms the actual sucker and the tissue of the body is a considerable plexus or convoluted section of the water-vascular tube not shown in the figure. I should say that I confirm Johnston's statement for *Ichthyotænia tidswelli* as to the spinelets covering the interior of the sucker for the present species. The strong muscles which retract the suckers and the scolex generally are massed in the neck-region of the strobila into a thick layer of longitudinally running fibres, which reduce the medullary region of the body very considerably. The appearance reminds one of *Dasyurotænia robusta*, where the neck-region has also particularly stout muscles *.

Text-fig. 2.



Two transverse sections through the strobila of the same species of *Ichthyotænia* (*Acanthotænia*).

The upper figure represents the "neck"-region, and shows the strong longitudinal muscle-bundles (M). The lower figure is from the posterior region of the body, and shows the absence of these muscles. T, testes; on the right are shown other parts of the reproductive system, also in an immature condition. The water-vascular tubes are shown white in both figures.

The fibres (see text-fig. 2) are collected into bundles of various sizes, which are close together and completely encircle the body.

* See Beddard, P. Z. S. 1912, p. 684, text-fig. 97.

Between this row of bundles and the subcuticular layer are other longitudinal fibres which are not massed so obviously into a series of separated bundles. Farther back in the body the bundles get smaller and further apart, and ultimately disappear altogether.

The strobila of this tapeworm shows posteriorly a very marked delimitation between the individual proglottids, which are constricted at their junctions and thus produce a necklace-like appearance, as is often seen in other tapeworms, e.g., *Davainea*. I describe the same appearance in an equally small or rather smaller species from *Varanus varius*. In transverse sections through the ripest segments that I have been able to examine, but which were by no means fully mature, the structure of the body is much like that of other *Ichthyotenia*. The general parenchyma is very delicate; the subcuticular layer of glandular cells is very marked, and the cells are deeply stained as compared with the neighbouring parenchyma.

I could find no layer of longitudinal fibres within the subcuticular layer. They seem to me to be as plainly absent from this species as from the others with which I deal in the present communication. Nor could I find any calcareous corpuscles with an obvious appearance like those of the second species of *Ichthyotenia* from this *Varanus*, which I shall describe later.

In the anterior segments of the body there are two *water-vascular tubes* on each side of the body, the dorsal tube nearly accurately overlying the ventral; they are about equisized. In the segments which I am now considering the ventral vessel is very large, comparatively speaking, and often lies right up against the subcuticular layer, thus emphasizing the difficulty—to which I also direct attention in other species—of distinguishing the cortical from the medullary layer. The much smaller dorsal vessel is present, but it is not always very easy to see.

With reference to the *generative organs* I am not able to say much, as they were immature. The ducts, however, pass between the two water-vascular tubes on their way to the exterior.

The *cirrus* is represented by an elongated wide tube into which the sperm-duct opens at the posterior end. This is surrounded posteriorly by a muscular sac, which is the cirrus-sac. The cirrus hardly narrows before its opening on to the exterior. The sperm-duct is only coiled once or twice upon itself, and this part lies within the cirrus-sac. The generative openings, it should be mentioned, occur either on one side of the segment or the other. The middle area of the proglottid is free from testes, of which three or four lie on each side of it; so that in a given proglottid the transverse rows of testes contain six or eight of these gonads. The ovary is median. I am aware that the above facts are not in any way distinctive of the species. They only prove that it belongs to the genus *Ichthyotenia*. From the characters other than those afforded by the generative organs it is hardly safe to attempt the definition of a new species of this genus. There is, indeed, nothing which positively prevents the inclusion of this

parasite of *Varanus niloticus* within the species *Ichthyotenia tidswelli*, excepting, indeed, the presence in the latter of a layer of longitudinal muscular fibres in proglottids with fully developed testes. These muscles I can only find anteriorly in my species. It appears to me, however, to be imprudent to give a name to the *Ichthyotenia* which I have just described until a good deal more is known about its anatomy than is contained in the present paper.

In addition to the small species which has just been described, *Varanus niloticus* is infested by a larger *Ichthyotenia* which I term *I. nilotica*, regarding it as an undescribed species.

I am uncertain about the length, inasmuch as I had to deal with fragments only of various sizes. The largest fragment with a scolex attached measured about 20 mm. But as the posterior region of this piece had not nearly acquired the dimensions of obviously mature fragments, at least 10 mm. can be, I think, safely added on to the length. The species is fairly slender, but not in the least thread-like, and the stoutest proglottids do not reach much more than .5 mm. in diameter. The most salient external feature of this species differentiates it at once from *Ichthyotenia varia* and *I. gracilis*; there is no external appearance of segmentation without a careful examination with a lens. Only the slightest constriction marks the boundary line of adjacent proglottids. In this feature the present species agrees with *I. biroi* and *I. tidswelli*. The ripe segments get to be longer than broad, but they are apparently never very long.

The scolex has the usual *Ichthyoteniid* characters. I only found two scolices, and in both the conical rostellum was long and is possibly therefore not retractile. The four suckers are clustered round its base and look forwards. I observed the usual dense investment of spinelets which led v. Linstow to bestow the name of *Acanthotenia* upon the genus. One of the two scolices was cut into a series of transverse sections for the purposes of further investigation. At the apex of the rostellum there was a distinct sucker-like depression carried on a narrow prolongation of the rostellum, which, however, showed no such great specialization in its tissues as the four suckers proper, though it is, I am sure, a permanent structure and not a mere temporary involution of the rostellar region. Such a structure has been discerned in other species of reptilian *Ichthyotenia*, and has been regarded as the homologue of the rostellum of other tapeworms. In the smaller *Ichthyotenia* from *Varanus niloticus* that has just been described the apical structure was obviously of the nature of a retractile rostellum.

The four suckers are borne upon prolongations of the scolex in which lie water-vascular tubes, which latter were not quite so conspicuous as in the last mentioned species of *Ichthyotenia*. It is these outgrowths of the scolex that are the motile parts of the scolex when the suckers are protruded or withdrawn. To a naked-eye examination the suckers appear to be sessile upon

the scolex. It is not impossible that we have here an intermediate state of affairs, where a true sucker (acetabulum), originally only an accessory structure (as has been held), has nearly completely replaced the phyllidium, of which comparatively small traces remain. In connection with this matter, it must be borne in mind that the systematic position of the genus *Ichthyotænia* is not yet settled. Some place it in a family, *Ichthyotæniidae* of the group *Tetraphyllidea*; while Lönnberg* dwells upon its likeness to *Tetrabothrium*, and Lühe † places the certainly closely allied if not congeneric *Crepidobothrium gerrardi* also in the genus *Tetrabothrium*.

The muscles which move the scolex are well developed in this species, but by no means so prominent as in the last species. This is remarkable when we consider that *Ichthyotænia nilotica* is the larger of the two species. On the other hand, I have no information as to the mobility of the scolex in the present worm. Immediately behind the scolex these muscles are massed into regular and, of course, longitudinally running bundles of fibres, which are not so large as are those of the last, and therefore do not contain so many individual fibres. These bundles lie below the subcuticular layer, and occupy exactly the position in which the longitudinal fibres of other species of *Ichthyotænia* are represented by Schwarz. But in the present species, as in the last, they only exist, and for a very short length, in the part of the body immediately following the scolex. I counted ten of these bundles in a section in the neck-region, only just behind the scolex; they form a complete ring, and thus lie without as well as within the water-vascular tubes. Further back the bundles decrease in number, and in mature segments are not recognisable. The greatest number of fibres in a bundle is 7 or 8.

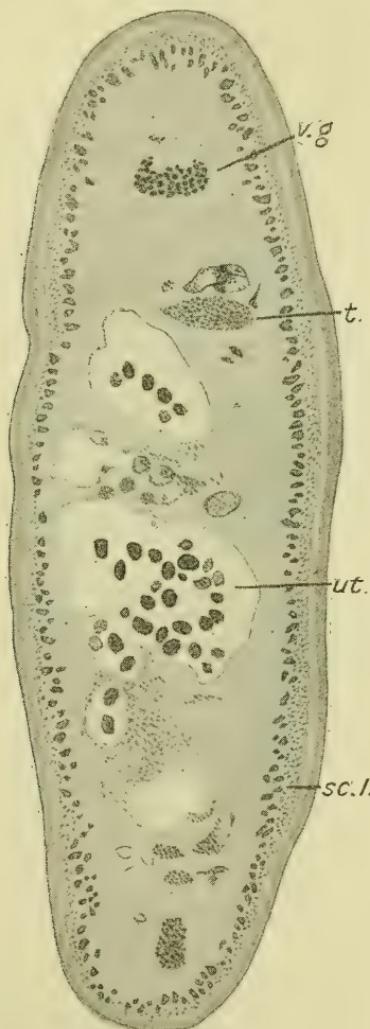
The structures seen in a transverse section of a proglottid (text-fig. 3) are not different from those of other species of this genus which I describe in the present paper. The delicate layer of longitudinal fibres below the cuticle is plain and also the very strongly marked subcuticular layer of darkly staining cells. I could find no longitudinal muscular layer beneath this, nor is there any boundary line that I could discover between the cortical and medullary parenchyma. *Calcareous bodies* were very evident here and there. The *water-vascular tubes* are very plain in the anterior region as two tubes on each side. These are not very different in calibre, and the dorsal and ventral of each side were more or less accurately superposed. In the mature segments I can find only one tube on each side, which I am inclined, mainly on account of its small size, to regard as the dorsal water-vascular tube. In longitudinal horizontal sections I could detect no evidence of more than a single water-vascular vessel on each side. I have also been unable to find any branching of this tube to join the corresponding vessel on the opposite side of the body. A single

* Centralbl. Bakt. u. Paras. xv. 1894, p. 801.

† In a footnote to a paper, "Zur Kenntniss einiger Distomen," Zool. Anz. 1899.

water-vascular vessel on each side of the body is also described for *Ichthyotænia biroi*. I find, however, that in completely ripe

Text-fig. 3.



Transverse section through the strobila of *Ichthyotænia (Acanthotænia) nilotica*.

sc.l. Subcuticular layer. *t.* Testis. *ut.* Uterus appearing as an irregular series of cavities with numerous contained embryos. *v.g.* Vitelline gland.

segments with embryos a much larger ventral vessel is present in addition to the dorsal.

There are various points in the structure of the reproductive system of organs which help to fix the distinctness of this species from others, and especially from *Ichthyotænia biroi*, to which it is most nearly akin. The testes occupy the greater part of each ripe proglottid, and there is no very definite median area free from them. There is nothing so definite, for instance, as the conditions figured by Schwarz in *Ichthyotænia nattereri**. In horizontal sections of a series of mature segments the difficulty of distinguishing the boundary lines between successive segments, plainly felt on examination of the entire worm with a lens, is increased by the lack of a definite break between the reproductive systems of each segment. There is an appearance of complete continuity not seen in corresponding sections of the other species which I have studied.

The *vas deferens* behind the cirrus-sac is closely coiled, this coiled region reaching quite or nearly halfway across the proglottid. The calibre of this region of the *vas deferens* does not vary in any appreciable way from point to point. That is to say, there is not, so far as I have been able to ascertain, any *vesicula seminalis* like that of *Ichthyotænia gracilis* described in the present paper. It is important to note this fact, since in *I. biroi* the existence of a *vesicula* behind the cirrus-sac has been stated, but Schwarz was not able to see it. The tangled coil of the *vas deferens* lies across the segment with a slight inclination towards the anterior margin. Within the cirrus-sac the *vas deferens* is also coiled.

The present species is the only one of those known to me at first hand, and which are described in the present paper, which possesses an armed *cirrus*. This organ, when protruded, is covered externally with very numerous and closely-set hooks. In sections through the cirrus-sac, where it is not protruded, the spines can be seen lining the canal of the cirrus. Schwarz figures in the case of *Ichthyotænia marenzelleri*† an actual protrusion of the cirrus-sac itself in an apparently unaltered condition. There is no doubt that in the species with which I am here concerned the outpushing of the cirrus is an eversion of the cavity of the cirrus, since the spines lining the latter become external in the everted organ.

The cirrus-sac and *vagina* open very slightly in front of the middle of the lateral margin of the segment. The generative apertures, of course, alternate from the side of the body in different segments, and there is also, as in many but not in all species of the genus, an alternation in the relative positions of the two orifices, the cirrus being sometimes anterior and sometimes posterior. The generative ducts pass between the dorsal and ventral water-vascular tubes, and there is in the present species no cloaca genitalis. This is rendered particularly evident in one specimen which I mounted entire in glycerine, and of

* *Loc. cit.* Taf. i. fig. 2, *h*.

† *Loc. cit.* Taf. iv. fig. 12, *c, b*.

which the cirri in many segments were extruded in various degrees of completeness. By the side of the cirrus in several proglottids was an oval projection, which is clearly the slightly everted or protruded vagina. Von Ratz has described the ovary of *Ichthyotenia biroi* as possessing digitiform processes. The ovary of *Ichthyotenia nilotica* is solid, and the two wings are not frayed out into processes; its appearance is, in fact, that of most species of the genus. The *vagina* when not fully mature is apt to be arranged, in that part of it which runs parallel with the cirrus-sac, in a sinuous line. In quite fully mature segments the vagina runs in quite a straight course in this region, and is considerably dilated, the calibre increasing as it passes back. It is not easy, however, to distinguish any part of it as a receptaculum seminis. But, on the other hand, it probably corresponds to the "spindelförmige Anschwellung" seen by von Ratz but not by Schwarz in the species *Ichthyotenia biroi*. After the pear-shaped swelling, which is quite plain in *I. nilotica*, the vagina dwindles greatly in calibre and becomes quite a narrow tube. That this dwindling occurs rather suddenly gives an additional appearance of a receptaculum seminis to the tract lying in front of it. As in other species, the vagina has an adventitious sheath formed by an ingrowth of the subcuticular layer. The vagina, when it reaches the middle of the body, passes back in a straight line, and is a little coiled in the neighbourhood of the ovary and before it becomes connected with the shell-gland. The vagina lies dorsally of the ovary and the uterus lies ventrally of the ovary in this region. The *shell-gland* is large, and extends across about half of the dorso-ventral diameter of the proglottid. It lies behind the median junction of the two wings of the ovary. Close to it, but upon the ventral side of the median, is the very obvious and strongly muscular "Schluckapparat." The vitelline glands form the usual lateral strips.

Before the eggs are ripe the *uterus* is visible as an empty cavity running antero-posteriorly through the whole of the middle of the segment. It is straight, with numerous closely adpressed and irregular outpocketings. The appearance may also be described as of a wide tube partially divided by numerous ingrowths of the wall. When fully formed and containing ripe embryos the uterus extends over the greater part of the segment from side to side, though it does not touch the lateral vitelline glands. It has an exaggeration of the same structure, the lateral diverticula being prolonged. In transverse sections through ripe proglottids (see text-fig. 3) it often appears as a series of more or less isolated and circular cavities occupying the middle of the segment. The ripe eggs lie loosely in the cavities of the uterus, generally aggregated into masses. The shell of the egg is very thin and unrecognisable, which distinguishes this species at once from *Ichthyotenia varia*, described later in the present paper. The eggs of *Ichthyotenia nilotica* are also—and, perhaps, therefore—distinctly smaller than those of the other species just mentioned.

While there is no need to insist upon the difference between *Ichthyotænia nilotica* and any of the other species described in the present communication, it is equally clear that there are considerable resemblances between that species and *I. biroi*. They are however, as I think, distinct. In the first place, our knowledge of these parasites of *Varanus* shows so far that, while a particular species of *Varanus* may harbour more than one species of *Ichthyotænia*, the same species of *Ichthyotænia* does not infest more than one species of *Varanus*. But there are also definite structural distinguishing marks. Of these the most important is the form of the ovary, which is quite normal in *I. nilotica* and peculiar in *I. biroi*. The spiny lining of the cirrus appears to be a further distinguishing mark, as Schwarz in his general account* of the anatomy of the genus says nothing about it.

An example of *Varanus varius* contained specimens of tape-worms which were clearly referable to two species—one very much larger than the other. The smaller species was represented by only one individual, which was a delicate thread-like worm, quite agreeing with *Acanthotænia tidswelli* of Johnston † in that “to the naked eye it appears like a piece of fine white thread.” Furthermore, the head is covered with minute densely-set spinelets. In other external characters, however, this small worm does not agree with *Acanthotænia tidswelli*. It is very much smaller, not reaching beyond 6 mm. in length as compared with 30 mm. for *Acanthotænia tidswelli*; there are abundant calcareous bodies, and the segments are rather clearly defined after the neck. The neck is quite short, and the segments soon get to be as long as they are broad. I counted altogether forty distinct segments after the neck.

Of these the last few had an oval outline and were deeply constricted at their junctions. Whether these were fully mature segments or not I am unable to state, as I could not see the organs of reproduction in the single specimen, which was mounted entire in glycerine; nor, indeed, could I see the generative pores. It is thus only by inference that the worm is referred to the genus *Ichthyotænia* (from which it is, as I think, very difficult to distinguish *Acanthotænia*), with which, however, all available characters agree in uniting it. I should say that, as might be expected, the head is entirely unarmed with hooks; it is considerably wider than the ensuing neck and the body for some distance. Mr. Johnston found the minute spinelets of the scolex in *A. tidswelli* to occur also upon the following proglottids. I have not been able to ascertain that this is so in my species. On account of the very scanty amount of notes which I am able to set down concerning this species, I do not for the present give it a name.

The second very much larger species, which I propose to name

* *Loc. cit.* p. 13.

† Proc. Roy. Soc. New South Wales, vol. xlili. 1909, p. 103.

Ichthyotænia varia, was represented by a great number of segments, but there was not a complete worm; so that I cannot judge of the length of the species. I can say something, however, of its dimensions as compared with the other species of *Ichthyotænia* which inhabit the genus *Varanus*. The longest piece measured 28 mm., and as this consisted of long and mature proglottids only, it is certain that a complete individual would measure more than 30 mm. A single proglottid, indeed, in one or two cases was 4 mm. long, and thus the worm is obviously relatively a large one as compared with other species that inhabit *Varanus*. The breadth of mature proglottids was fully a millimetre, so that this species of *Ichthyotænia* is not at all thread-like but flattened and ribbon-like: indeed, in all external characters a typical member of the genus. Among the numerous fragments of varying sizes and maturity was one piece which included a scolex, which is, I think, probably not to be referred to the same species. I shall deal with the characters of this individual, which measured 34 mm., later. The pieces of the large worm were investigated by sections, and also pieces were mounted entire, stained and unstained, in glycerine.

In transverse sections of mature proglottids (see text-fig. 4, p. 18) the flattened character of the worm is very obvious. The medullary parenchyma is much more coarsely spongy than I have observed it to be in many tapeworms, and I have been unable to detect a transverse layer of muscle separating the medullary from the cortical layer. Moreover, the cortical layer must be thin, for the coils of the vas deferens extend dorsally and ventrally to just beneath the cellular subcuticular layer. The latter layer is very strongly marked, as appears always to be the case in this genus. The large cells are very deeply stained by haematoxylin. Between it and the cuticle is a delicate layer of longitudinal fibres; but I can find no other layer of longitudinal muscles such as are figured by Schwarz* and Johnston†, or have been described by myself in the present paper in an *Ichthyotænia* from *Varanus niloticus*.

It would, I think, be difficult to miss such a layer in my preparations were it present. But while there is no definite layer of muscles, there are certainly here and there large longitudinally running fibres which I have observed both in transverse and longitudinal sections. But they are scarce. As for the transverse layer which Schwarz figures‡ as occupying the greater part of the medulla, I have only been able to notice a rather stretched condition of the parenchymatous meshwork, particularly at the extremes of the proglottids where there are no gonads developed. There are very probably muscles in this meshwork running in a transverse direction; there certainly are such fibres running in a dorso-ventral direction. I cannot, however, find thick layers such as I understand Dr. Schwarz to insist upon in *Ichthyotænia calmettei*. Owing to the coarseness of the medullar meshwork

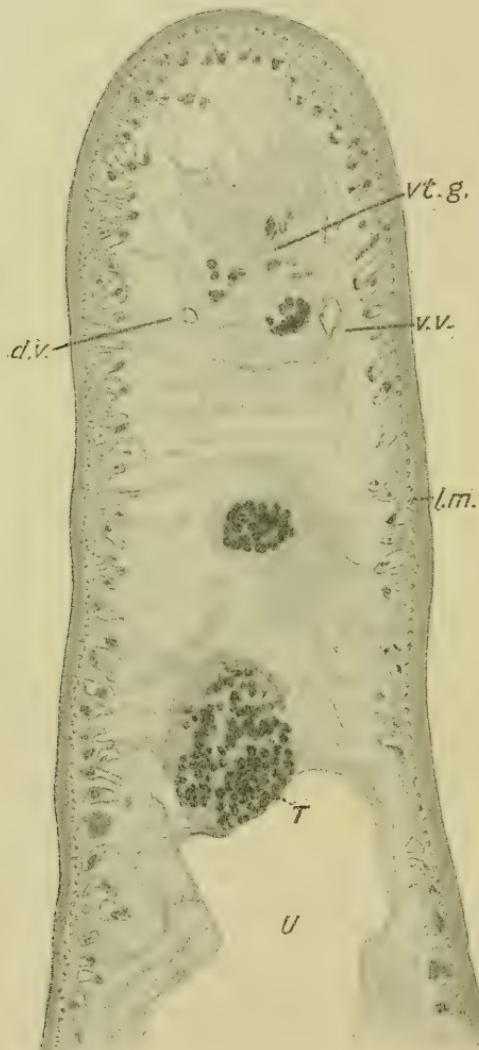
* Loc. cit. Taf. i. fig. 4.

† Loc. cit.

‡ Loc. cit. pl. iii. fig. 10.

and the fact that the spaces in the meshwork are often approximately circular in transverse section, it is not always easy to detect the water-vascular tubes. They are, however, often quite easy to see, and in such cases I have seen two on each side—a

Text-fig. 4.



Transverse section through the strobila of *Ichthyotenia (Acanthotenia) varia*.

d.v. Dorsal water-vascular tube. *l.m.* Layer of delicate longitudinal muscles lying between cuticular and cellular subcorticular layer. *T*. Testis. *U*. Cavity of uterus. *vt.g.* Vitelline gland. *v.v.* Ventral water-vascular tube.

dorsal and a ventral, fairly evenly superposed. The calibre of these vessels is not large, and they do not differ greatly in size. I have observed branches going towards the exterior, but have not traced them as far as an opening. The longitudinal trunks lie sometimes to the inside of, and sometimes above and below, the vitelline mass.

The *testes*, as can be best seen in transverse sections, form a layer, only one deep, of 80–100, or even more, in a single proglottid. While there is not a median space entirely free from testes in this species such as occurs in some other species of the genus, the testes are often not quite so densely arranged in the median area; they occur there, however, even when the uterus is fully formed, in the thickness of the strands which form its diverticula. The testes do not extend back to the sides of the ovary, but anteriorly they may (or may not) reach quite to the end of the segment.

The *vas deferens*, after issuing from the cirrus-sac, forms a dense coil, which extends over about half of the breadth of the proglottis. It lies at right angles to the long axis of the proglottis, and is directed neither forwards nor backwards. The tube forming this coil is thin-walled and of wide calibre. Within the cirrus-sac the sperm-duct is also coiled, but it is here of much less calibre. I was not able to see any hooks in connection with the copulatory apparatus. The aperture of the cirrus-sac was always in front of the orifice of the vagina. The *cirrus-sac* is flask-shaped as in other Ichthyotæniids and in many tapeworms, but there is not so sharp a demarcation between the two regions as is so commonly the case. The walls are thin and obviously muscular; they are not thicker in the neck of the cirrus. It is necessary to insist upon the muscularity of the walls of the cirrus-sac since Schwarz* has written of that of *Ichthyotænia nattereri*: "Die Blase (i. e. of the cirrus-sac) ist dünn, nicht muskulös." It should be mentioned that the alternating generative pores lie some way behind the middle of each proglottid †.

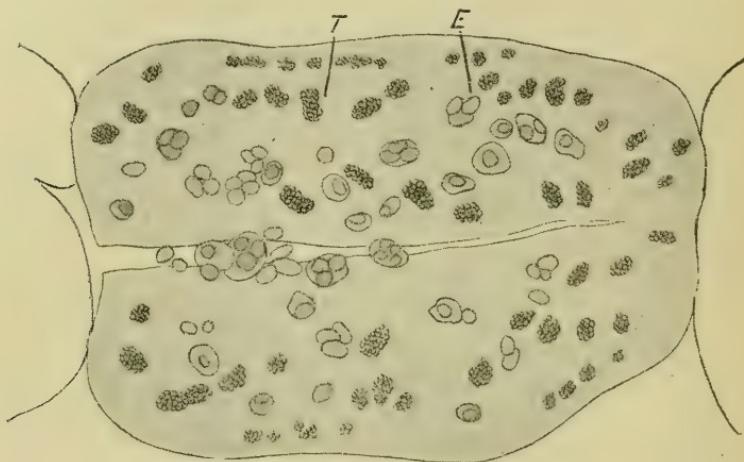
The *ovary* is, as usual, in two portions, with a slender bridge in the middle line uniting the two. The contour of the ovary, though irregular, is not pulled out into digitiform processes as in *Ichthyotænia biroi*. The *vagina* runs parallel with the cirrus-sac and posterior to it, as already mentioned. This region of the tube is wider than that lying behind; but the vagina is here not coiled, and, indeed, scarcely wavy in outline. Posteriorly between the wings of the ovary the vagina is coiled for a short distance.

* *Loc. cit.* p. 20.

† In one proglottid, which was fully ripe and contained numerous embryos, I observed a remarkable variation which I have not seen before in a tapeworm. The cirrus-sac with the succeeding large and complex coil of the vas deferens was particularly obvious; but the most careful examination failed to show a vagina lying either in front of or behind the cirrus-sac. But by following up the vagina from the ovary forwards it was found to bend in the reverse direction and to open on to the opposite side of the proglottid, nearly on a level with, but slightly behind, the line of opening of the male pore. I regard this state of affairs as merely a variation, but I have not read of any parallel instance.

The dilated region of the vagina (the dilatation is very slight) has apparently not got a ciliated lining. It has a covering of glandular cells externally which is obviously continuous with, and presumably derived from, the glandular subcuticular layer of the body generally. The shell-gland is large and conspicuous, and the "Schluckapparat" is particularly muscular and strong. I have observed a duct arising from each peripheral vitelline series, and there is in short nothing of particular note in this part of the generative system.

Text-fig. 5.

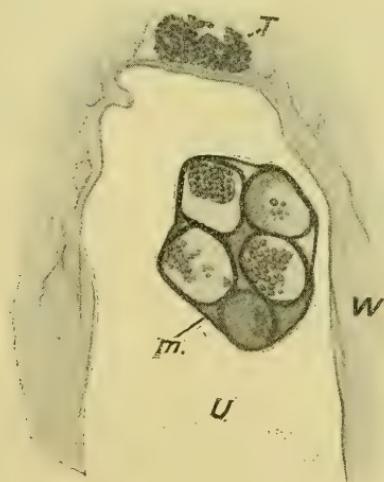
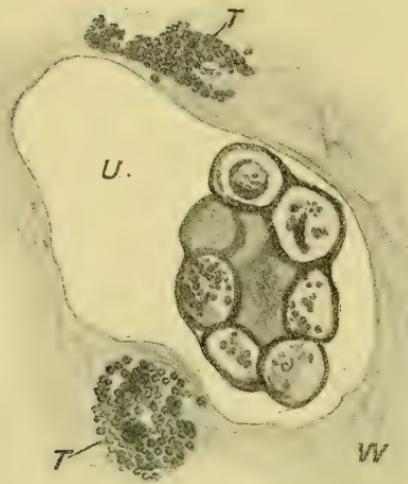


View of a ripe proglottid of *Ichthyotenia (Acanthotenia) varia*, to illustrate the extent of the mature uterus.

E. Egg-clumps scattered through the uterus, which occupies the greater part of the proglottid. T. Testes.

The *uterus* of this species when fully formed and containing embryos occupies a good deal of the middle region of ripe proglottids (see text-fig. 5). Its aspect in transverse sections is quite like that of *Ichthyotenia nilotica* described above, and no definite specific differences appear to me to be obtainable from a comparison of these organs. The eggs, however, are highly characteristic when the present species is compared with *Ichthyotenia nilotica*. They are disposed for the most part within the cavity of the uterus in clumps of varying numbers, perhaps 12–20 in each batch of eggs. Three or four of these, or often more, may be visible in a single transverse section. The mode of aggregation of the individual eggs (which, of course, contain embryos) in *Ichthyotenia varia* is thus different from that which is found in *Ichthyotenia nilotica*. They also appear very considerably larger, the difference in size being principally a question

Text-fig. 6.



Transverse sections through two compartments of the uterus of
Ichhyotænia (Acanthotænia) varia.

- m.* Outer sheath enclosing several embryos, each of which has also its own separate sheath. *T.* Testes. *U.* Cavity of uterus. *W.* Wall of uterus.

In the upper figure a clump of embryos is shown in which the outer membrane is not present or just represented by a rudiment on the left side. In the lower figure is shown a clump of embryos in which there is an outer sheath involving the whole mass.

of the increased shell. Text-figure 6 (p. 21) shows a clump of eggs in transverse section within a compartment of the uterus, pressed to whose boundary walls on either side is a testis. This figure may be compared with text-figure 3 (p. 13), which illustrates a corresponding view of an egg-clump in *Ichthyotænia nilotica*.

The masses of eggs of *Ichthyotænia varia* are, however, sometimes rather different from that represented in the drawing to which attention has just been called. Occasionally (as shown in text-figs. 6, 7) each mass of eggs is surrounded by a common

Text-fig. 7.



Two isolated masses of embryos from the uterus of *Ichthyotænia (Acanthotænia) varia*, viewed entire as transparent objects, to show the sheath which encloses a variable number of embryos.

sheath or shell, within which lie the eggs, or rather embryos, each with its own shell. The same state of affairs is quite plainly visible in preparations of a proglottid mounted entire (text-fig. 5) in glycerine, where the eggs appear to be contained within a glass ball. In the text-figure to which I have referred the outer sheath is represented as thin; it is often considerably thicker, and I have seen it with a few thin obliquely-set spiny processes. An aggregation of the eggs within the uterus appears also to occur in *Ichthyotænia succifera* of v. Ratz, but there are not sufficient details given to compare with the conditions observed by me in *I. varia*. As to the egg-masses enclosed within a common sheath, they suggest spores within a sporangium, and give rise to the idea (which I admit to be otherwise unsupported) of the division

of an originally single ovum to form a number—thus lying within one sheath.

In describing the last mentioned species I have referred to a scolex which probably belongs to a third species, and a further examination of this and of some other fragments has convinced me that this is so, and that I am right in describing these worms under a different name.

The present species is intermediate in size between the two last mentioned. As already suggested, it is probably at least 40 mm. in length, for the largest fragment, that including the scolex, is quite 34 mm. long. The head is wider than the body which follows, and the greatest breadth is not attained for some time ; the elongated ripe segments are about .5 mm. in width. This worm is therefore much more slender than *Ichthyotænia varia*. The rostellar region was depressed and the four suckers look distinctly upwards. I ascertained that the scolex was densely beset with fine spinelets as in other species. There are, of course, no hooks. The neck is very short indeed, and the proglottids very soon get to be as long as they are broad ; later on they become about three times as long as they are broad.

The general structure of the body when examined in transverse and longitudinal sections is very like that of *Ichthyotænia varia*, which has just been described. The strands forming the meshwork of the parenchyma are, however, much finer, and the interstitial homogeneous ground substance is deeply stained, whereas a corresponding immersion in the staining-fluid of pieces of *Ichthyotænia varia* produced no result in the way of tinging the ground substance.

The segments, however, from which I made these sections, although elongated, are rather younger than those which I examined (and which alone I was able to examine) in *Ichthyotænia varia*. The outer longitudinal muscular layer lying outside of the subcuticular layer was obvious ; but, as in *I. varia*, I could find no other definite longitudinal layer. The subcuticular cells were strongly developed and very darkly stained. The *water-vascular tubes* are two on each side and superposed, the dorsal lying often fairly accurately above the ventral.

The disproportion in calibre between the two tubes and their actual size is greater than in the last species. I can find no trace of transverse vessels. I could find no calcareous bodies, which are present, though not abundant, in *I. varia*. The principal difference, however, between the present species, which I propose to call *Ichthyotænia gracilis*, and *I. varia* lies in the reproductive organs. In the first place, the opening of the external pore is rather nearer to the middle of the proglottids—sometimes, in the case of shorter proglottids, actually median on the lateral margin. It is never so posteriorly situated as in *I. varia*. I counted 80 *testes* in one proglottid, which are more definitely arranged in this species in two lateral bands, the median area being largely and

sometimes entirely free from testes. The *sperm-duct* shows an important difference from that of *Ichthyotenia varia*. Almost immediately after leaving the cirrus-sac it becomes dilated into a vesicula seminalis in a fashion not met with in the last described species. Moreover, the coil of sperm-duct which ensues is considerably less in extent than that of *I. varia*, and instead of running out towards the middle of the segment is directed rather obliquely and forwards. There is thus a greater angle formed with the vagina. The structure of the cirrus-sac appears to me to show no obvious differences from that of the *Ichthyotenia* which has just been described. The vas deferens is coiled within it in a precisely similar fashion. As a rule the vagina, which lies parallel with the cirrus and is here somewhat dilated, lies posteriorly to that sac; but I found it in one instance to open in front of the cirrus-sac. *Ichthyotenia gracilis* thus differs in this character also from *Ichthyotenia varia*. In the neighbourhood of the ovary the vagina is a good deal coiled; but my account of the female organs of this species is very incomplete, since they were not fully mature. The shell-gland was large and well forward in development; but I could not definitely recognise the lateral vitelline strips. The uterus was in the condition of a delicate thread commencing anteriorly and extending far back in the middle line of the segment.

I am therefore able to distinguish plainly three species of *Ichthyotenia* occurring in the gut of *Varanus varius*, which are apparently graduated in size, and of which the smallest (to which I do not venture to give a name for the present) is the only one that bears any external likeness to the only species of *Ichthyotenia* (viz. *I. tidswelli*) as yet recorded from this particular species of *Varanus*. I have, however, shown ample reasons for regarding it as different. There can also be no question as to the marked distinctness of *I. varia* and *I. tidswelli* quite apart from size, and here there appears to be too great a discrepancy to allow of specific identity. *I. tidswelli* differs from my species by its total lack of calcareous corpuscles, by the alternating relative position of cirrus-sac and vagina, by the disappearance of the uterus and the lodgment of the ripe ova in the parenchyma*, by the freedom from testes of the middle region of the proglottid, and by the strong muscular layers of longitudinal fibres lying within the subcuticular layers of cells.

With my *Ichthyotenia gracilis* Johnston's *I. tidswelli* agrees more closely; yet they are, as I think, different. In the first place, *I. gracilis* cannot possibly be described as "like a piece of fine white thread," a description applied by Johnston to *I. tidswelli*. I can find neither in *I. gracilis* nor in *I. varia* the strong muscular layer figured by Johnston, and also in other species by Schwarz. Finally, the existence of what may be

* The author of the paper upon *I. tidswelli* is not, however, able to insist absolutely upon this.

termed a vesicula seminalis appears to be distinctive of *I. gracilis*, and thus contributes largely to the establishment of its distinctness as a species.

This latter character also precludes the possible identification of *I. gracilis* with either of the two species described by v. Ratz, from which both *I. gracilis* and *I. varia* differ also in other particulars. In *I. biroi* the genital pore lies in front of the middle of the segment instead of behind it, the neck is long, and the proglottids, even posteriorly, are not plainly separable to the eye; the water-vascular tube is single on each side. It is therefore not identical with either of my species. In *I. saccifera* the positions of male and female pores alternate as in *I. gracilis*; but the cirrus-sac is described as round, as opposed, I presume, to oval, which is its shape in *I. gracilis*, in which species, moreover, the proglottids are longer; but the two species are obviously very near to each other.

Finally, I do not think that these species can be confused with v. Linstow's *Acanthotænia shipleyi* from *Varanus salvator*, for it is very minute, only 13·8 mm. in length by 1·4 mm. in breadth; the segmentation is not marked; the cirrus-sac lies behind the vagina and is crescentic in shape. The author, however, seems to have missed the marginally situated vitelline glands, since he identifies as such what is, I think, certainly the ovary. The description setting forth the characters of a new genus and a new species is, however, a very brief one.

§ An Ichthyotæniid from the Indian Cobra (Naia tripudians).

OPHIDOTÆNIA NALÆ, gen. et sp. n. (See p. 35.)

The genus is already known to exist in a good number of snakes, of which a list was given by v. Linstow in 1907* and by Schwarz in the following year†. There are at most seven species known from snakes, if we except *Crepidobothrium gerrardi*‡ from *Boa*, and regard it, mainly by reason of its horseshoe-shaped suckers, as a distinct genus. I have now to describe a form which occurs in a species of snake which has not hitherto yielded examples of the genus. I obtained at least three specimens (there were three scolices) of an Ichthyotæniid from an Indian Cobra which died in the Society's Gardens on April 18th, 1912. The longest individual measured, after preservation in alcohol, 110 mm., and had a greatest breadth posteriorly of 1·5 mm.

The anterior end of the body gradually narrows up to the small scolex, which is, however, wider than the neck which immediately ensues. In none of the specimens was the rostellum very conspicuous for its size and extension beyond the suckers. Indeed, I found that in the specimen which I examined by means of transverse sections there was no prolongation of the head at all

* "Helminthen von Java," Notes Leyd. Mus. xxxix. 1907-8, p. 85.

† "Die Ichthyotænien der Reptilien, &c.," Inaug.-Diss. Univ. Basel, 1908.

‡ Baird, Proc. Zool. Soc. 1860, p. 446; Monticelli, Atti Soc. Nat. e Mat. Modena, (4) i. 1899, p. 9.

beyond the suckers. The very first section of the series, which was nearly transverse, showed simply two suckers back to back with very little tissue between them. The scolex, indeed, appears to be very like that of *Ichthyotenia nattereri* as figured by Schwarz. Naturally, therefore, as in that species, the present is provided with neither rostellum nor a fifth sucker. Nor is there the least trace, that I can discover, of the presence of minute spines upon the scolex, such as characterise the species of *Ichthyotenia* from *Varanus*. I gather from Schwarz that in other Ichthyoteniids from Ophidia there is the same lack of minute spinelets upon the rostellum. I may add that I cannot find these spines lining the cavity of the suckers, a matter upon which I lay some weight, since Johnston has particularly asserted their presence in this situation in *I. tidswelli*.

The actual neck of this worm—*i. e.*, that portion of the strobila immediately following the scolex—is short, the segmentation of the body commencing early. The proportion between depth of the segments and transverse diameter is more equal here than later, where the body appears, on account of its great breadth, to be very thin. Also the dorso-ventral diameter is not greater in the neck-region than posteriorly. In transverse sections through this neck-region, one important difference is apparent between this species and those which I have been able to examine among the species peculiar to the genus *Varanus*. The parenchyma of the body is uniform throughout, and appears to contain no muscular fibres at all. It may be that there are a few which I have missed on account of their tenuity; but it is quite clear that there is in the present species nothing like the thick encircling layer of longitudinal fibres which I have described above in *Ichthyotenia nilotica* and *Ichthyotenia* sp. from the Nilotic Monitor. This peripheral layer of muscles, were it present, could hardly, I should imagine, have been missed, so conspicuous is it in the two species from *Varanus*.

In the wider posterior part of the body the segmentation is quite clear, though the segments, as is the case with the other species of the genus, do not overlap. They get to be about twice the length of their width. In transverse sections, through not fully mature segments, the width in comparison to the depth is greater than that which is figured by Schwarz for some species of *Ichthyotenia* from Serpents. In some quite mature segments which I examined the difference from *I. nattereri*, etc., in this respect appears to be less; and in those segments the two ends of the section were wider than the middle region and formed an almost circular-projecting area, the whole section having thus a dumbbell-form with a long cross-bar. The minute structure of the body differs in some respects from that of the *Ichthyotenia* considered in the present communication, but seems to agree on the whole with that of species of *Ichthyotenia* from Ophidia. The cuticle is thick and homogeneous; the layer of longitudinal fibres beneath it is very distinct. The sub-

cuticular layer of large pear-shaped cells is deeper than in the *Ichthyotænia* from *Varanus*, and, like the layer in them, is very conspicuous and deeply staining. Some way below this glandular layer is a layer of stout longitudinal fibres, such as are figured by Schwarz in species of *Ichthyotænia* from Serpents, a layer which I have been quite unable to find in such species from *Varanus* as I have examined. This layer in the present species is very conspicuous, and the differential staining of logwood emphasises it very well. The layer is usually more than a single fibre deep, but in places only a single fibre deep. The greatest number of fibres which I have found in a dorso-ventral direction is not more than four. The layer thus appears to be thicker than in *Ichthyotænia nattereri* and *I. calmettei* figured* by Schwarz. The layer seems, as Schwarz has pointed out, to form the boundary line between the cortical and medullary regions of the proglottids. The latter author has directed attention to a peculiarity in the disposition of the transverse fibres which differs from that of all other tapeworms. He described and figured† these fibres as lying within—*i. e.*, not on—the boundary of the medullary parenchyma. I have myself observed in the present species many such fibres in proglottids not fully mature. In fully mature proglottids I have not detected them. They are irregular and certainly occupy a good deal of the medullary region. They are not, however, by any means so plain as the longitudinal fibres just described.

The *water-vascular tubes* in the neck-region are plainly two on each side. They show a character here which is at least not very common among Tapeworms. Both the tubes, which are fairly accurately superposed, have distinctly thick walls and are rather larger than usual. Moreover, the lumen is slit-like, the tubes presenting the appearance of being compressed dorso-ventrally; there is no doubt that in the fully mature proglottids only one of these tubes is present on each side of the body.

The *generative organs* conform with the Ichthyotæniid plan, but show numerous differences in details from those of the other species already considered in the present paper. The *testes* present the usual arrangement, but are, perhaps, more strictly confined to the lateral regions of the proglottid than in some other species described in the present paper. When they are fully ripe the testis seems to become entirely converted into a mass of spermatozoa, which does not wholly fill the cavity in which it lies. In transverse sections a series of these cavities are seen to lie side by side, only separated by a thin strand of medullary parenchyma.

The *vas deferens* forms the usual Ichthyotæniid coil, but seems to be of less calibre than in the species of this genus from *Varanus*. This coiled region extends to quite the middle of the

* *Loc. cit.* Taf. i. fig. 4 and Taf. iii. fig. 10, *lm.*

† *Loc. cit.* Taf. iii. fig. 10, *tvm.*

Text-fig. 8.



A series of transverse sections through generative ducts of *Ophidotænia naiae*.

- A. The cloaca genitalis.
- B. The extremity of the cirrus (δ) and the vagina (φ).
- C. The terminal part of the cirrus lying without the cirrus-sac (δ) and the vagina (φ) already narrowed in calibre.
- D. Cirrus-sac (δ) containing coiled cirrus; (φ) vagina. The glandular cells besetting the cirrus are shown black.

proglottid. The *cirrus-sac* is longer than broad, but not of a very regular oval; its walls are thin but muscular in structure, the number of fibres in a longitudinal section not appearing to be more than one or two. Within the cirrus-sac lies the cirrus, which widens out considerably in its last section—*i. e.*, that lying immediately after the external aperture; the cirrus lies in many coils and is throughout of considerable calibre. In structure it differs from the cirrus of many other tapeworms (see text-fig. 8) by the very thick layer of circular muscular fibres which surrounds it. The muscles are increased at the broad terminal portion of the cirrus. Outside the muscles is a layer of pear-shaped glandular cells which deck the whole of the cirrus. The same arrangement, or something very like it, apparently exists in *Ichthyotænia nattereri* according to the figure and description by Schwarz *. In that species, however, the glandular layer is neither so thick nor so widely distributed as in the present.

I have observed in several proglottids the complete protrusion of the cirrus, which is everted in the usual way and thus is broader at the base than at the tip.

I have found no protrusion of the cirrus-sac itself such as has been referred to by Schwarz. The cirrus when fully everted is not half the width of the proglottid. There is thus a difference from *I. nattereri*, in which species (very like the present in many respects) Schwarz asserts that the protruded organ equals in length the whole diameter of the segment. Moreover, he figures the cirrus as very much more closely coiled within the cirrus-sac and therefore longer than I have found to be the case with my new species. I have not found any spines upon the cirrus. As in many species of *Ichthyotænia*, the cirrus opens sometimes in front of and sometimes behind the vagina. The cloaca genitalis into which both open is of some depth.

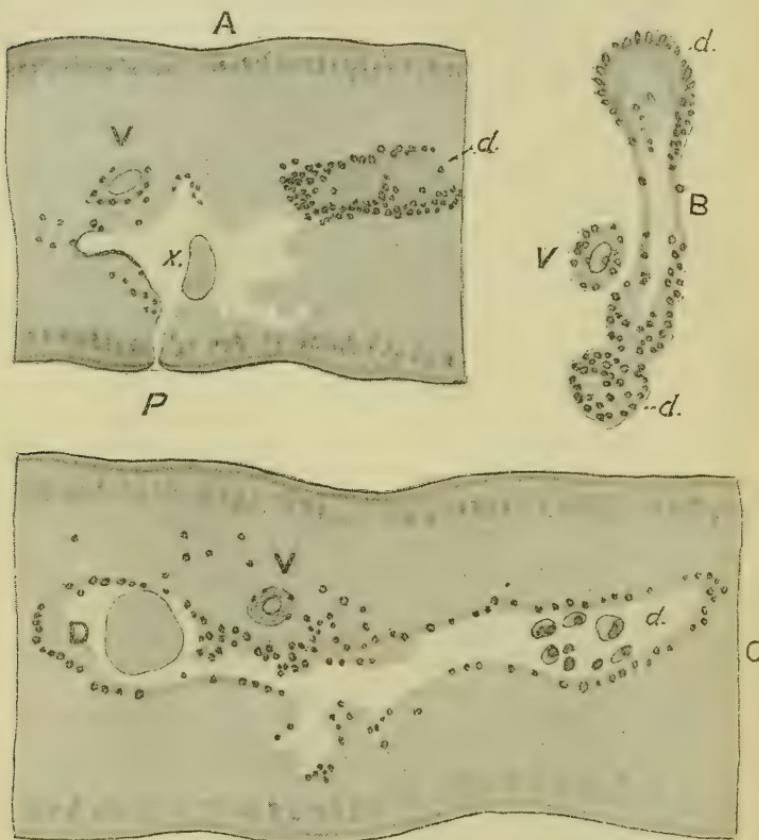
At its outer end (see text-fig. 8 B) the vagina is quite as wide as the somewhat dilated end of the cirrus; but it very soon narrows into a tube of less calibre. The wide distal region is fully as muscular as the cirrus and it is furnished in addition with a strong circular muscular sphincter. Outside of this is a layer of glandular cells, which forms with those belonging to the cirrus, and which have been already described, a common layer surrounding the two tubes in one circle. In this region the vagina is not ciliated. A little further back the vagina has its own separate coat of glandular cells as has the cirrus. Later on the vagina becomes narrower and is ciliated internally. It bends back in the usual position and is coiled posteriorly in the region of the ovary. The straight part of the vagina which passes backwards lies dorsally to the uterus, but not quite in the median line.

The *ovary* extends on either side up to the laterally placed vitelline strips. I could not find any signs of a *shell-gland* which

* *Loc. cit.* Taf. ii. fig. 5.

is so conspicuous in certain species from *Varanus* described above. On the other hand, the "Schluckapparat" was large and

Text-fig. 9.



Ophidotaenia naiæ.

A. Section through a portion of a ripe proglottid.

d. A diverticulum of the uterus. *P.* External pore of the uterus. *V.* Vagina.
x. A mass of secreted substance lying within the main stem of the uterus.

B. A section through the uterus cut transversely and showing the diverticula (*d*) of the median stem. *V.* Vagina.

C. Part of a transverse section of a ripe proglottid.

In the centre is seen the uterus, the median stem of which sends down an outgrowth towards the exterior of the body, of which the external orifice is seen in **A**.

D. A mass of secreted substance lying in one diverticulum. *d.* Eggs in process of development lying in the other diverticulum. *V.* Vagina.

muscular. This and adjacent parts of the female ducts extended back beyond the ovary to the hinder border of the proglottid.

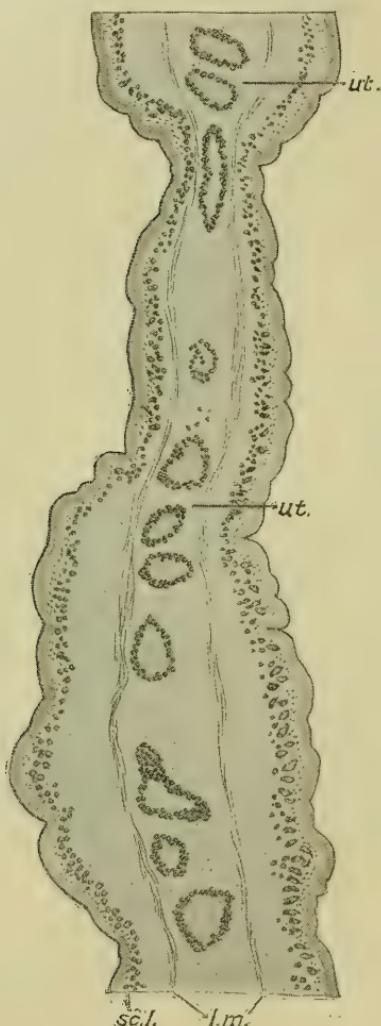
The *uterus* of this worm shows a very remarkable feature which in detail is different from anything that has been hitherto described in any tapeworm. I believe that I am right in saying that an independent uterine opening is not found in any of the Tetraphyllidea or Cyclophyllidea—that it is, in fact, confined to the Pseudophyllidea. The present species, allied to a genus which perhaps stands intermediate between the Tetraphyllidea and Cyclophyllidea, is thus so far unique in possessing independent uterine openings which lie, as in *Bothriocephalus*, etc., upon the ventral surface of the body. While there is this general resemblance to the lower group of tapeworms, there are plenty of differences in detail between the conditions which obtain in this species and those which characterise the Bothriocephalidae and their immediate allies. When the ripe proglottid is viewed as a transparent object in its entirety, *i. e.*, without undue pressure, the uterus is seen to occupy the middle region of the body, and to be a quite narrow tube with regular paired diverticula, which extend but a little way laterally.

In addition to this there were in the median line of the proglottid a series of medianly situate orifices, one behind the other, extending through the greater part of the proglottid and rendered especially conspicuous by virtue of the fact that granules of black pigment had accumulated in every instance near to these orifices. I could not in such preparations actually see the tube which put this series of orifices into communication with the underlying uterus. But the orifices, on focussing down, were quite plain and could not be missed. In transverse sections (text-fig. 9) all of the structural characters were easily confirmed and extended. The uterus is seen to occupy but a comparatively small space in the middle of the proglottid, by reason of which the present species contrasts with *Ichhyotenia varia* or *I. nilotica*. The uterus in a given section consists of a median stem which is a small tube; from this arise continually a series of paired diverticula, which are at times somewhat ear-shaped or crescentic in outline. The curvature is downwards and they expand at their blind ends (text-fig. 9 B). The diverticula furthermore show a difference in structure from the median stem of which they are outgrowths. Their exterior is more or less covered with a layer (text-fig. 9 A) of pear-shaped glandular-looking cells, which resemble those found decking the cirrus and which are also of the same nature as the glandular cells of the subcuticular layer.

These uterine pores are quite as visible in sagittal sections (text-fig. 10) and are then seen to exist along the entire length of the proglottid, being situated at intervals from each other. Such sections also show very much better than the transverse sections the fact that the median stem of the uterus is continuous throughout the proglottid; they furthermore enable me to state that the number of paired diverticula of the median stem in a

given proglottid was over twenty ; they doubtless vary, but it is important to note that they are numerous. In this particular

Text-fig. 10.



Sagittal section through part of a proglottid of *Ophidotaenia naiæ*.

l.m. Longitudinal muscular layer. *sc.l.* Subcuticular layer.
ut. Diverticula of uterus seen in transverse section.

feature the present species does not differ in any way from other Ichthyotæniids. I do not think that the number of external

pores is as great as that of the diverticula. But I cannot reckon these pores up exactly. The actual pore itself is as a rule small, but its position is rendered obvious by the gradual thinning to a point of the cuticular layer on either side. Where the pore is small the downwardly directed tube from the median stem of the uterus is also slender and narrow.

Not infrequently, however, the pores are greatly enlarged, and in such cases I have observed the orifice plugged with granular matter exuding from the orifice. Very often too, and in association with the stretching of the uterine pores, the ventrally directed outgrowths of the uterus are much dilated. It might be suspected perhaps that these large "pores" are simply the expression of a rupture caused by the turgescence of the uterus. That this is not the case is shown by the thinning of the chitinous cuticle round the pore; it is clearly not torn across, as it would be were it a question of a rupture.

If there were any doubt as to this tube with its paired diverticula being the uterus, the existence of eggs within the tube dissipates that doubt. These possess a tolerably thick shell and they appear to resemble the eggs of *Ichthyotenia varia*. But in addition to these eggs (which had segmented and were of course really embryos) there were others with no apparent shell (text-fig. 9, C d). Attention has been called to the diverticula of the uterus, which are small and whose walls are beset with numerous long-stalked pear-shaped glandular cells. If it were not for the comparatively wide lumen of these diverticula they might easily be mistaken for shell-glands—so similar is their glandular investment to that of a shell-gland. I am disposed, indeed, to believe that this is the actual function of the diverticula. For there are to be noted here and there in the uterus round homogeneous masses of a substance (text-fig. 9 A x, C d) which stains precisely like the egg-shell, and which may very well be a secretion of the glandular cells referred to. It will be furthermore recollect that this worm apparently does not possess a proper shell-gland*.

The function of the uterus is thus enlarged, and it is in this species not merely an egg-holder.

* It seems to me to be possible that an analogous state of affairs exists in *Mesocestoides*. I have lately spent some time in studying a species of that genus from a black Serval, which I do not feel able to place accurately but have regarded as *M. litterata*. In the uterus masses of amorphous matter lie here and there among the embryos. This substance is represented by Hamann (Zeitschr. f. wiss. Zool. 1885) as a nucleated tissue, with which I cannot agree. I think that we have to do here, as in the species described above, with a secretion of uterine glands. The hinder part of the uterus is regarded by Hamann as the equivalent for shell-gland which he has stated to be absent in *Mesocestoides*. Zschokke, however (Mém. Inst. Genève, 1889), has asserted the presence of a real shell-gland in the normal position. If a shell-gland is present in the species which I studied it is certainly very inconspicuous. I may point out, moreover, that in the genus with which the present paper deals the shell-gland may be present or absent. In any case, the commencement of the uterus in the *Mesocestoides* examined by myself had a glandular wall, which quite possibly corresponds with the glandular diverticula of the uterus in the species from the Indian Cobra.

It should be mentioned that the eggs were not in any way aggregated into balls such as I have described in the species *Ichthyotænia varia*.

I have finally to point out that although I have not come across any description of external uterine pores in any Cyclophyllidean, Späthlich* has described and figured in *Tetrabothrium* a cord of cells passing from the uterus which may well be, as he suggests, the remains of an external duct and pore. This comparison gains some additional force by other points of likeness between *Ichthyotænia* and *Tetrabothrium* insisted upon by Lönnberg †.

§ On the Genera of the Family Ichthyotæniidae.

Having surveyed the anatomy of a number of worms undoubtedly referable to this family of Tapeworms, it remains to be seen how they should be placed in genera, whether in more than one genus.

Relying mainly upon variations in the scolex and its suckers, Braun ‡, in 1899, allowed three genera—viz., *Ichthyotænia*, *Corallobothrium*, and *Crepidobothrium*. Braun does not accept Lönnberg's § view that *Tetrabothrium* should be included in the same family; neither does Ransom in his review of the Cyclophyllidea ||, nor Führmann ¶ in his well-known essay upon the Cestodes of Birds. It appears to me, however, that Lönnberg's *Tetrabothrium trionychium* is not congeneric with other species referred to that genus. It has, in fact, the peripherally situated vitelline glands of *Ichthyotænia*, with which it also agrees in its alternating generative pores. In *Tetrabothrium* ** the generative pores are unilateral and the vitelline gland †† lies in front of the ovary.

While, therefore, there are certain points of agreement between *Tetrabothrium* and *Ichthyotænia*, I do not think that they can be placed together so closely as would be implied by union in so small a subdivision as a Cestode family. Linstow §§ gave the name of *Acanthotænia* to a small Ichthyotæniid from *Varanus salvator*, which name was also accepted by Johnston §§ in his account of a worm of the same genus from *Varanus varius*. This generic name is perhaps hardly accepted by Schwarz ||| in his recent monograph upon reptile Ichthyotæniids. But the last-named author has

* Zool. Jahrb. xxviii., 1909.

† Centralbl. Bakt. u. Paras. xv. 1894, p. 801.

‡ In Bronn's 'Klassen und Ordnungen des Thierreichs,' Bd. iv, p. 1706.

§ Loc. cit.

|| "The Taeniod Cestodes of North American Birds," Bull. U.S. Nat. Mus. no. 69, 1909.

¶ "Die Cestoden der Vögel," Zool. Jahrb. Suppl.-Bd. x., 1908.

** Späthlich, "Studien über Tetrabothriene," Zool. Jahrb. xxviii. 1909; and generic diagnosis of Ransom.

†† Späthlich, loc. cit. Taf. 28. fig. 25, dst.

‡‡ Centralbl. Bakt. u. Paras. xxxiii. 1903, p. 534.

§§ Proc. Roy. Soc. N. S. W. 1909.

||| "Die Ichthyotæniiden &c.," Inaug.-Diss., Basel, 1908.

pointed out that in his opinion the reptile Ichthyotæniids do agree together and differ from the fish Ichthyotæniids in a number of points which he enumerates.

Schwarz comes to the conclusion that the reptilian Ichthyotæniids form a group which is characterised by the peculiar spiny outgrowths of the egg-shell, by the fine spines upon the rostellum, by the complicated coil of vas deferens and the protrusible cirrus-sac, and finally by the arrangements of the transverse muscles.

It does not appear to me that all of these features are distinctive of the reptilian Ichthyotæniids; for the coiled vas deferens is found in other species of *Ichthyotænia* not from reptiles; the fine spines upon the rostellum and early segments of the body are at least not to be found in the species from the Cobra which I describe in the present paper. The peculiar and delicate spines which deck the egg-shell are figured and described by Schwarz only in *I. nattereri*. The cirrus-sac does not seem to be protrusible in the way which he figures it, in the species of *Ichthyotænia* which I have described in the present paper from various species of *Varanus*. These characters are, in fact, not sufficiently general or not sufficiently distinctive to form a group. It must be admitted, however, that Schwarz suggests no name for his group, and thus does not unduly emphasize it.

It appears to me, on the other hand, that we can separate off as a distinct group of generic rank the species of *Ichthyotænia* which inhabit, not reptiles generally, but the lizard genus *Varanus* only. And if so, we must obviously term this genus *Acanthotænia*, adopting v. Linstow's name. The genus will be chiefly distinguished by the fine spiny covering of the scolex and anterior segments, and, as I think, also by the character of the longitudinal muscular layer. I am disposed to think that, as I have described in several species in the present paper, the internal layer of longitudinal fibres is found only in the anterior region of the body. A third character is perhaps afforded by the comparatively large size of the rostellar region, which is apt to be insignificant in the snake Ichthyotæniids. Further than this I do not think we can go at present. I propose the name of *Ophidotænia* for a new genus to include at any rate the species which I describe in the present paper from the Indian Cobra. Its most salient anatomical character is of course afforded by the structure of the uterus and by the ventrally and medianly placed external orifices of the same.

This genus *Ophidotænia* also contrasts with *Acanthotænia* in the lack of internal longitudinal muscles anteriorly and in their presence posteriorly. The inconspicuous rostellar region affords another distinguishing mark. In all of these characters, with the possible exception of those offered by the uterus, this genus agrees with other snake Ichthyotæniids. We cannot, therefore, as yet attempt to fix the limits of this genus *Ophidotænia*, in fact not until the structure of the uterus has been reinvestigated in other Ichthyotæniids in the light of my own discovery recorded here.

While it is not apparently possible to distinguish as a separate genus the two species which inhabit Amphibians, I am of opinion that Lönnberg's species from *Trionyx ferox* will prove to be not a *Tetrabothrium* or an *Ichthyotenia*, but another genus closely allied to the latter. At present the chief anatomical difference appears to be the limitation of the testes to the middle of the proglottid. Finally, I think that we must retain *Crepidobothrium* for those Ichthyoteniids, inhabitants of Ophidia, which possess horseshoe-shaped suckers.

§ Résumé of the principal new Facts.

It may be useful to abstract from the foregoing pages a short résumé of the more striking new facts which I have been able to ascertain :—

(1) Worms of a group belonging (in agreement with its usual definition) to the genus *Ichthyotenia* are more conveniently to be removed and placed in the genus *Acanthotenia* of von Linstow. These worms are found in several species of *Varanus* and are limited to that genus. The same species does not occur in more than one species of *Varanus*, but a single species of *Varanus* may contain more than one species of *Acanthotenia* parasitic in it.

(2) In some at any rate of the species of *Acanthotenia* there is a layer of longitudinal muscles limited to the head and neck and separating the medulla from the cortical region; these fibres are arranged in bundles. This layer disappears and does not occur in the body behind the neck.

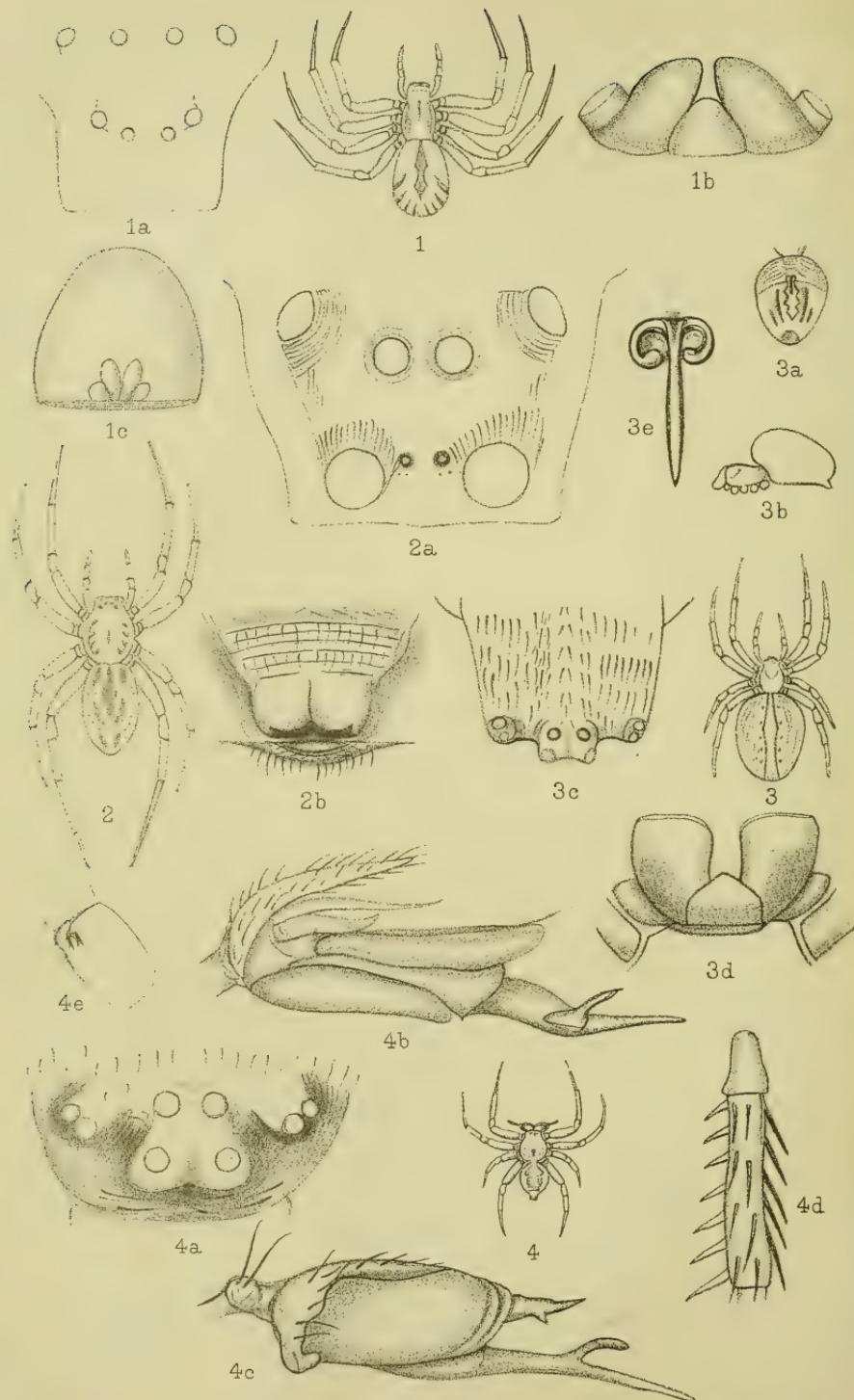
(3) It follows from the above statement that in the body generally there is no demarcation between the medulla and cortex.

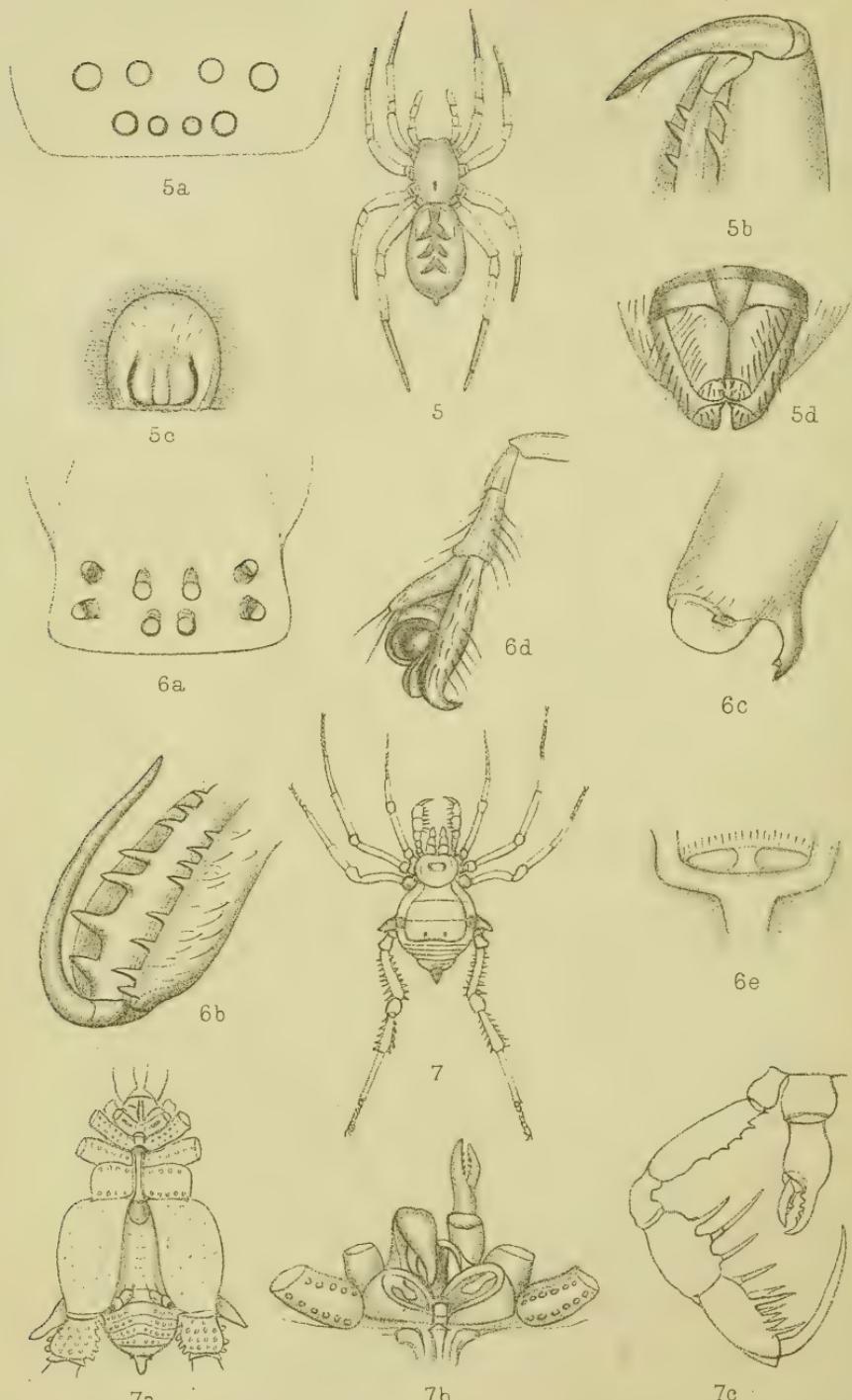
(4) The existence of numerous ventrally situated openings of the uterus in a tapeworm which is assigned to a new genus *Ophidotenia* is a new fact so far as concerns the Cyclophyllidea (=Tetracotylea).

(5) The diverticula of the uterus in *Ophidotenia*, instead of being of a character similar to the median stem, are closely beset with gland-cells and probably secrete the shell of the ova, there being no shell-gland in this worm. There is here a possible likeness to *Mesocestoides*, but the details are different.

(6) The mature eggs of *Acanthotenia varia* not only tend to cling together in balls, as has been described in other species of the genus, but a series of distinct eggs are enclosed also, in many cases, within a common sheath, which suggests a division of one original egg.

(7) A remarkable abnormality is recorded in the same species, where in one proglottid the male and female ducts open on to opposite sides of the body.





2. Some Falkland Island Spiders.

By H. R. HOGG, M.A., F.Z.S.

[Received October 8, 1912 : Read November 12, 1912.]

(Plates I. & II.*)

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The small collection of spiders from the Falkland Islands described below was brought to this country by Mr. Rupert Vallentin, who has been good enough to afford me the opportunity of examining them.

Connected generically with Patagonia and the Magellanic Region, they are all apparently new species. Gathered as they have been over a period of two years, they comprise only six species of spiders and one Opilio, of Sorensen's genus *Sadocus*, with a fair number of specimens of some of the species.

Three of these are Argiopidae which are easily conveyed by the wind, and supply no argument for a former land connection between these islands and the mainland of America.

Family ARGIOPIDÆ.

Group ARGIOPEÆ.

Genus ARANEUS Clerck.

ARANEUS VALLENTINI, sp. n. (Pl. I. figs. 3–3 e.)

The colour as seen in specimens taken from spirit is as follows:—

Cephalothorax pale yellow-brown with longitudinal streaks of long white hair, rather bare on the sides but a pale marginal streak all round. Mandibles pale yellow-brown at the base, dark brown at the apex. The fangs are dark brown at the base, dingy yellow-brown at the points.

* For explanation of the Plates see p. 50.

The lip and maxillæ have broad margins of pale yellow, the outer and lower portions being black-brown, fringes dark grey.

The sternum is black-brown, with upstanding grey hair.

The coxæ of the legs are bright yellow-brown, the femora reddish brown with pale grey hair, the patellæ black-brown, tibiae yellow-brown with dark band at fore end. Metatarsi and tarsi darker yellow, with brown rings and dark brown spines and bristles.

The abdomen is pale yellow-brown on the back and sides, with five pairs of dark muscle-spots on the former, each side of a scalloped pale yellow longitudinal streak reaching from the base to the posterior end. On the under side in front of the genital fold is a wedge-shaped dark streak, narrowing posteriorly, with a narrow dark streak on each side and smaller dark streaks nearer to the rear outside the latter again. The spinnerets and epigyne are black-brown.

Mr. Vallentin has furnished me with a coloured drawing of the specimens when first taken. This shows a greyish-green cephalothorax and bright emerald-green abdomen with white longitudinal streak. The femora are bright crimson, the other joints yellow with brown rings.

The *cephalothorax* is longer than broad, rounded at the sides, convex, with the cephalic part well raised and distinctly separated by lateral depressions from the thoracic part. The hairs are long, pointing forward, and laid in streaks on the cephalic part; on the thoracic they point downwards on the sides and upwards on the marginal streak. From the rear margin as far up as the end of the pars cephalica is a rhomboidal area bare of hair; this, however, is hidden by the overhanging abdomen.

The rear row of *eyes* is slightly recurved seen from above, but straight from in front. The front row strongly recurved from each position.

The four median eyes are raised on a distinct prominence which overhangs the clypeus. They are equal in size, the rear pair a diameter apart; the front pair, 2 diameters apart, are $1\frac{1}{2}$ diameters from the rear. The side eyes are similarly situated on rather large prominences, and are about half a diameter from each other. The *clypeus* is about $1\frac{1}{2}$ diameters of the front median eyes, but curves under the eye-space to the insertion of the mandibles, and vertically is not so much.

The *mandibles* are slightly convex at the base but thence rather straight to the front edge. A few straggling hairs at the base and along the inner edge. The fangs are long and powerful. There are four teeth on the outer margin of the falx-sheath, the third one being stout and twice as long as the others; on the inner margin are three equal teeth of moderate length.

The *lip* is broader than long, oblong at the base to about half of its height, thence sloping to a point anteriorly. This part is all pale. The *maxillæ* are roughly triangular, broadest in front, with very broad pale margins.

The *sternum* is a broad shield-shape, slightly convex, hollowed

in front, with rounded projections at each fore corner. It narrows to a point posteriorly, where there are two little round bosses, one each side; in front of each coxa it is incurved, and there is a raised hump.

The legs are moderately thick in the femoral, patellar, and tibial joints, the latter being thickened at the anterior end; the metatarsi and tarsi are cylindrical and much finer. On tibia 1 and 2 are thick upstanding bristles, and a single row of six upstanding spines on the under side. There are about five pectinations on the superior tarsal claws, thin at the base but thickened anteriorly. The femoral joint of the palpi is short; the tibial joint is longer than the patellar, and there are upstanding bristles and spines on the distal joint. There are several pectinations on the palp-claw.

The abdomen, which overhangs the cephalothorax as far as the lower end of the cephalic part, is ovate, convex, rounded in front but slightly pointed. It is widest at about one-third of its length from the base, where there are small corner humps which disappear in some specimens, thence narrowing to a blunt rounded point at the rear end. There are two pairs of large muscle-spots followed by three pairs smaller and less distinct.

The epigyne has a scape furnished with two prominent lobes on the lower margin, and a specially long appendix of the *A. productus* type, 2 mm. long, which reaches more than halfway to the membranous base of the spinnerets. The latter are large and well developed, and of the normal type.

The hair covering is short, fine, and downlying, but there is a ring of longer bristly hairs round the base of the spinnerets.

The measurements (in millimetres) are as follows:—

	Long.	Broad.					
Cephalothorax...	4½	1½ 3½	in front.				
Abdomen.....	11½	10					
Mandibles	2						
		Trochanter Coxa.	Patella & femur.	Metatarsus & tibia.			
Legs	1. 2. 3. 4.	1½ 1½ 1 1½	5 5 3½ 5	5½ 5 3 5	5 4½ 3 4	= = = =	17 16 10½ 15½
Palpi	3 4	2 2	2 2	2 2	=	6¾	

There are numerous specimens of females but no males. The species is said to be common about the Camp. There was a green-coloured egg-sac with the specimens but it was torn out of shape.

ARANEUS GLOBIGER, sp. n. (Pl. I. figs. 4-4 e.)

Male. Cephalothorax dingy yellow-brown, lightest on the cephalic part, darker on the thoracic, with a marginal stripe again paler. The hairs are long, forward pointing, yellowish

grey. The mandibles are brown at the base and pale yellow brown anteriorly. Fangs pale yellow-grey at the point, browner at their base.

The lip and maxillæ have a margin, equal to half their respective breadths, of pale yellow-grey, the remainder black-brown. The sternum is black-brown with yellow-grey hairs. The legs and palpi are bright yellow, with darker bands, yellowish-grey spines and hair and brown bristles.

The abdomen, both on the upper and under sides, is dark brown irregularly mottled with paler yellow spots not forming any special pattern, and grey hair.

The *cephalothorax* is longer than broad, only slightly convex, straight in front, and is rounded at the sides and rear; it has a short longitudinal fovea behind the cephalic part leading into a broader transverse depression. The cephalic part is bounded by long shallow depressions, and is rather thickly covered with bristly downlying hair all pointing forward; the thoracic part is sparsely covered with shorter hair, with the exception of a marginal stripe which is again more closely covered.

The rear row of *eyes* is straight or, seen from in front, slightly procurved. Both the median four and each side pair of eyes are on one raised prominence overhanging the clypeus in front; the median are equal in size, a diameter apart behind and two diameters in front; the laterals are adjacent, the rear rather larger.

The *clypeus* is narrow.

The *mandibles* are short and flat, with short curved fangs.

The *lip* is broader than long, curved at the sides, pointed at the apex, and less than half the length of the maxillæ. The latter are broadest at the top, curving rather away from where, on the inner side, they meet the lip, and have pale margins half their own width.

The *sternum* is shield-shaped, convex, hollowed from the two front corners, broadest in the middle, pointed at the rear where the rear coxae are contiguous. The hairs are long, rough, and rather upstanding.

The *legs* are thickly covered with downlying hair, upstanding bristles, and numerous short thick spines. The tibiæ of the first pair are dilated at the anterior end, being there twice the thickness of the metatarsi, and are furnished with short spines. The tibiæ have a single row of short spines on the outer side, besides numerous spines on the inner and under side. The *palpi* are short and slight, with a remarkably large development of bulb stylus and other organs, covering the whole front of the mandibles and standing out at each side; a long elbowed stylus has a projection at the bend. The tibial joint is short and globular, with two long bristles protruding therefrom.

The *abdomen* is roughly quadrangular, longer than broad, narrowed but rounded at the front and rear ends, with angles at the broadest part not quite one-half of the distance from the base to the rear; at these angles are slight rounded prominences

and two smaller ones at the rear end. It overhangs the cephalothorax almost to the end of the cephalic part.

The measurements (in millimetres) are as follows:—

	Long.	Broad.				
Cephalothorax ...	4	{ 1½ in front. 3				
Abdomen.....	4½	3½				
Mandibles	1½	1½				
	Coxa.	Tr. & fem.	Pat. & tib.	Metat. & tars.		
Legs.....	1.	1	4	4½	4	= 13½
	2.	¾	4	4	4	= 12¾
	3.	¾	2½	2	2½	= 7½
	4.	¾	4	3	3½	= 11¼
Palpi	½	1	½	2½	=	4½

There is one male specimen.

An undeveloped female, similarly coloured, has the rear and side prominences much more prominent, and a pale median longitudinal streak down the abdomen on the upper side.

Subfamily TETRAGNATHINÆ.

Genus TETRAGNATHA Latreille.

TETRAGNATHA INSULATA, sp. n. (Pl. II. figs. 6 a-6 e.)

Female. The cephalothorax, mandibles, legs, and palpi pale yellow, the hairing on the latter dark grey; the eyes black, the laterals on black tubercles and black patches behind the rear median. The sternum nearly black at the edges, but yellow in the central streak, with dark grey hair. The abdomen is uniformly dark yellow-grey all over, with dark grey hair.

The *cephalothorax* is longer than broad, the cephalic part being raised and divided off from the thoracic by distinct depressions.

The *eyes* are all equal in size. Both the front and rear row are recurved, the laterals being as far apart from each other as the front and rear medians. The rear median are $1\frac{1}{2}$ diameters apart and $2\frac{1}{2}$ from the laterals. The front median are one diameter apart, $1\frac{1}{2}$ diameters from those of the rear row, and 3 from their laterals. The front median eyes are one diameter distant from the margin of the elytrae.

The *mandible* in the female has on the inner margin of the falx-sheath one tooth at the upper end and two teeth at the lower end, about the level of the top of the maxillæ; on the outer margin there is one tooth at the upper end, and two at the lower end below those on the inner margin.

In the male there are eight teeth on the inner margin of the falx-sheath. Near the upper end of the outer margin are two much larger teeth, of which the second is the longest, and then

after an interval, five about the same size as those on the inner margin but reaching farther down the edge. On the outer side near the fore end is a projection bifurcated at its anterior end.

The sternum, lip, and maxillæ are of the normal type.

The abdomen slightly overhangs the cephalothorax, it is broadest at about one-fourth of the distance from the base, thence tapering to the posterior rounded end. On the under side in the female is a raised fold of the skin reaching from the centre of the epigyne to the spinnerets.

The measurements (in millimetres) are as follows:—

Male.

	Long.	Broad.				
Cephalothorax ...	$2\frac{1}{2}$	$\left\{ \begin{array}{l} 1 \\ 1\frac{1}{2} \end{array} \right.$	in front.			
Abdomen.....	5	$1\frac{1}{2}$				
Mandibles	2					
Legs.....	1. $\frac{3}{4}$ 2. $\frac{4}{3}$ 3. $\frac{1}{2}$ 4. $\frac{1}{2}$	Coxa. $6\frac{1}{2}$ $4\frac{1}{2}$ $2\frac{1}{2}$ $4\frac{1}{2}$	Tr. & fem. tib.	Pat. & tib.	Metat. & tars.	
Palpi.....	$\frac{3}{4}$	$1\frac{1}{2}$	$\frac{3}{4}$	$8\frac{1}{2}$ 5 $2\frac{1}{2}$ 4 $1\frac{1}{2}$	= = = = =	$22\frac{3}{4}$ $14\frac{3}{4}$ $7\frac{1}{2}$ $13\frac{1}{2}$ $3\frac{3}{4}$

Patella shorter than tibia.

Female.

	Long.	Broad.				
Cephalothorax ...	$2\frac{1}{2}$	$\left\{ \begin{array}{l} 1\frac{1}{4} \\ 2 \end{array} \right.$	in front.			
Abdomen.....	7	$2\frac{1}{2}$				
Mandibles	$1\frac{1}{2}$					
Legs.....	1. $\frac{3}{4}$ 2. $\frac{4}{3}$ 3. $\frac{1}{2}$ 4. $\frac{1}{2}$	Coxa. 6 $4\frac{1}{4}$ $2\frac{1}{2}$ 4 $1\frac{1}{2}$	Tr. & fem. tib.	Pat. & tib.	Metat. & tars.	
Palpi.....	$\frac{3}{4}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$7\frac{1}{2}$ $4\frac{1}{2}$ 2 4 $1\frac{1}{4}$	= = = = =	$20\frac{1}{4}$ $13\frac{1}{2}$ 7 $13\frac{1}{2}$ 5

Patella much shorter than tibia.

Family CLUBIONIDÆ.

Group CLUBIONEÆ.

Genus PHILISCA E. Simon.

PHILISCA COLULATA, sp. n. (Pl. II. figs. 5-5 d.)

Female. The cephalothorax is dark yellow-brown in the centre of the cephalic part, dark brown at the sides. The thoracic part

is dark yellow-brown, with a narrow darker brown median longitudinal stripe in the anterior portion, and a dark brown marginal stripe; the downlying hairs are yellowish grey, with a few longer upstanding brown hairs over the posterior part.

The mandibles are black-brown, with upstanding grey hairs along the inner side. The fangs black-brown at the base, become bright red towards the anterior end. The lip and maxillæ are yellow-brown with paler edges, brown hairs on these and the sternum, which is much darker, almost black-brown.

At the base of the abdomen, on the upper side, are two pale yellow areas divided by a longitudinal brown median streak, and bounded by brown at the sides and right in front. The median streak reaches to about halfway, where it spreads out into three chevrons followed posteriorly by a uniformly mottled brown area. It is thinly covered all over with yellow-grey downlying hair and brown upstanding bristles.

On the under side a darkly mottled wedge-shaped area broadest in front extends the whole distance from the base to the spinnerets; this is bounded by pale yellow-brown which extends to the dark brown sides.

Legs and palpi dingy yellow, with dark grey hairs and spines.

The *cephalothorax* is longer than broad, convex, straight in front, slightly rounded at the sides, with no side depressions but a quite short median longitudinal fovea at the upper part of the rear slope.

Eyes. The rear row of eyes is slightly procurved; they are about equal in size. The median are two diameters apart and one diameter from their respective laterals. The front row is shorter and straight. The laterals are as large as the rear eyes and slightly more than their diameter therefrom; the median, two-thirds the diameter of the laterals, are their own diameter apart and one-half of the same from the side eyes. The area covered by the four median eyes is broader than long.

The *clypeus* is as broad as the front side eyes.

The *mandibles*, rather stout and broad, are kneed at the base, thence descending perpendicularly. Fangs rather long and strong. Two teeth on the inner margin of the falx-sheath, and one longer between two small on the outer margin.

The *maxillæ* are upright, straight on the inner side, broadest at the upper margin, thence curving inwards to the insertion of the palpi. There is a long tuft of bristles on the upper part of the truncature followed by shorter bristles to the lower end of same.

The *lip* is rather longer than broad and more than half the length of the maxillæ. It is narrowed at the base, just above which it is widest, narrowing to a slightly hollowed truncate anterior end.

The *sternum* is convex, $1\frac{1}{2}$ times longer than broad, straight in front, whence it widens out to the middle and then again narrows to a point between the not quite contiguous rear coxae.

It is hollowed for each coxa, between which and itself is a marginal space. The base of the lip joins it on the upper edge but not the maxillæ. The rough upstanding hair thereon is thicker near the edge than in the centre.

The *abdomen* is longer than broad, truncate in front, broadest about the middle and pointed at the rear end, where the spinnerets are terminal. It is moderately thickly covered with short upstanding and finer downlying hair. The ventral tracheal fold is rather close behind the spinnerets.

The inferior spinnerets are one-jointed and conical, close together and rising from a membranous base; the superior are longer, flatter and broader, with a short pointed second joint. There is a large well-formed colulus in front of the inferior pair.

The *legs* are moderately stout, the tarsi and metatarsi cylindrical. On the two latter joints of all legs is a scopula with cluftufts of flat pointed bristles. The two claws have about five pectinations. There are numerous long spines on the upper side of the femora and on the tibial and metatarsal joints.

The *palpi* are rather short and fine, the femoral joints incurved, and spines on the tibial and distal joints. The tibia is longer than the patella.

The measurements (in millimetres) are as follows:—

	Long.	Broad.					
			Pat. Metat.				
	Coxa.	Tr. & fem.	& tib.	& tars.			
Cephalothorax...	4	$\left\{ \begin{array}{l} 1\frac{3}{4} \text{ in front.} \\ 3 \end{array} \right.$					
Abdomen.....	6		$3\frac{1}{2}$				
Mandibles	$1\frac{3}{4}$						
Legs	1. 2. 3. 4.	1 1 $\frac{3}{4}$ $1\frac{1}{4}$	3 3 3 4	$3\frac{1}{4}$ $3\frac{1}{4}$ 3 4	3 3 3 $4\frac{1}{2}$	= = = =	$10\frac{1}{4}$ $10\frac{1}{4}$ $9\frac{3}{4}$ $13\frac{3}{4}$
Palpi		$\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{4}$	$1\frac{1}{4}$	=	$4\frac{1}{2}$

This would appear to belong to M. Simon's genus *Philisca* from Tierra del Fuego etc. It differs from *P. navarinensis* Tull., to which it approximates, in having the side eyes quite $1\frac{1}{2}$ diameters apart instead of 1 diameter; in having the rear median twice as far from one another as from the side eyes instead of equidistant, and the row procurved instead of straight; the front median decidedly less than three-fourths of the laterals; the second pair of legs as long as the first, instead of shorter; at the rear end of the dark median line on the back three black arrow-headed cross markings instead of testaceous spots; and the fourth pair of legs longer in proportion to the others; the epigyne is also apparently different.

One female found under a stone in Camp.

Family AGALENIDÆ.

Subfamily CYBÆINÆ.

Group CYBÆEÆ.

Genus EMMENOMMA E. Simon.

EMMENOMMA FALKLANDICA, sp. n. (Pl. I. figs. 2-2 b.)

Female. The cephalothorax is yellow-brown, darker in the lateral depressions, black-brown over the eye-space, rather thickly covered with yellowish-grey hair. Mandibles, lip, and maxillæ bright yellow-brown with dark grey hair; fangs dark red-brown; sternum somewhat darker, with a brown median patch and upstanding brown bristles towards the rear.

The abdomen is a greyish yellow, with a pair of black rectangular longitudinal patches on each side of the base and a median black quadrilateral, broadest in the middle and pointed at each end, reaching to rather more than halfway; on each side of this again are longitudinal black patches and two more similar at the rear end. The under side is dingy yellow all over, with pale yellow-grey hairs and brown upstanding bristles.

The legs are rather bright yellow, with dark grey hairs and spines and brown upstanding bristles on the coxæ and under side of the femora, and pale grey rings on the femoral, tibial, and metatarsal joints.

The *cephalothorax* is longer than broad, with about four well-marked depressions on each side, and a long and deep longitudinal fovea reaching from the rear slope to the cephalic part.

The rear row of *eyes* is recurved; the tops of the median pair, which are three-fourths of their diameter apart, reach to the line joining the lower side of the laterals, which are rather more than their diameter away. The front lateral eyes are $1\frac{1}{2}$ times the diameter of the rear median, $1\frac{1}{2}$ times their diameter from one another, and about $1\frac{1}{2}$ times that distance from the rear laterals. The front median are one-fourth the diameter of, and in a line with, the upper edge of the laterals.

The *mandibles* are stout and strong, kneed at the base, where there are long upstanding bristles; at the apex there is a fringe of downy hair.

The *lip* is about as broad as long, straight in front, and broadest one-third of its height therefrom. The *maxillæ*, slightly bending over the lip, are rounded anteriorly, where they are broadest and about twice the height of the lip.

The *sternum* is shield-shaped, $1\frac{1}{2}$ times as long as broad, hollowed in front and pointed at rear end between the not quite contiguous last pair of coxae.

The *abdomen* is oval, truncate in front, the hair covering scanty, rather short and fine.

The legs are only moderately stout, tarsi and metatarsi cylindrical; long stout spines on the metatarsi and tibiae of all legs. A brush of short bristles, not amounting to a scopula, on the under side of the tarsi.

The superior claws are long and rather straight, with a few pectinations at the basal end only.

The tibial joint of the palp is twice as long as the patella, and the distal joint is furnished with spines and bristles.

The measurements (in millimetres) are as follows:—

	Long.	Broad.				
Cephalothorax...	4	{ 1 $\frac{3}{4}$ in front. 3 $\frac{1}{2}$				
Abdomen.....	6	3 $\frac{1}{2}$				
Mandibles	2					
		Coxa.	Tr. & fem.	Pat.	Metat.	
Legs.....	1.	1	3 $\frac{1}{2}$	4 $\frac{1}{4}$	3 $\frac{3}{4}$	= 12 $\frac{1}{2}$
	2.	1	3 $\frac{1}{4}$	4	3 $\frac{1}{2}$	= 11 $\frac{3}{4}$
	3.	1	3 $\frac{1}{4}$	3 $\frac{1}{2}$	4	= 11 $\frac{3}{4}$
	4.	1	4	4 $\frac{1}{4}$	6	= 15 $\frac{1}{4}$
Palpi	$\frac{1}{2}$	1 $\frac{1}{2}$	1 $\frac{1}{2}$	1	=	4 $\frac{1}{2}$

This agrees with M. Simon's genus *Emmenomma* from Cape Horn, except as to its median eye area. It differs from *E. oculatum* in this being only 1 $\frac{1}{2}$ times as long as broad instead of 3 times the width.

One female only.

Family THOMISIDÆ.

Subfamily PHILODROMINÆ.

Genus PETRICUS E. Simon.

PETRICUS SIGNATUS, sp. n. (Pl. I. figs. 1-1 c.)

Female. Cephalothorax black-brown mottled with dark yellow brown, and scantily covered with downlying flat white hairs; a thick band of same across the front of the clypeus.

Mandibles black-brown, smooth at the base, with a few brown bristly hairs towards the anterior end. Fangs dark yellow-brown. Sternum, lip, and maxillæ patchy dingy yellow-brown, with rough white hair. Coxæ of legs dingy darkish yellow, with dark brown on the under side of the femur, patella, and tibia, and downlying dark hairs and brown upstanding bristles and spines. Metatarsus and tarsus paler yellow, with thick whitish scopula on the latter and anterior part of the former.

The upper side of the abdomen is black-brown with downlying flat white hairs and upstanding brown bristles; a dark longitudinal median stripe extends from the base to about two-

thirds the length, and there are four dark stripes perpendicularly down each side at the rear end. Underneath, dingy dark yellow-brown with thinner whitish downlying hair.

The cephalic part of the *cephalothorax*, which is only slightly longer than broad, is convex, thick, and square anteriorly, separated by a broad shallow depression from the thoracic part, which is also convex and slopes evenly to the margin.

The rear row of *eyes* is straight, or viewed from above slightly recurved, but, owing to the curve of the headline, slightly pro-curved from in front; it lies on the front margin of the upper part. From this point the forehead falls perpendicularly, so that the recurved front row, two-thirds the length of the rear row, looks straight forward. The laterals of each row are equal in size, each on separate tubercles. The eyes of the rear row are equidistant, the median slightly smaller than the lateral. The front median pair are half the diameter of the side, three of their diameters apart, and two of the same from their laterals. A line drawn across their upper margin lies near but well below that across the lower margin of the laterals. The *clypeus* is as broad as the length of the quadrangle of median eyes, which is twice as long as its breadth.

The *mandibles* are conical, perpendicular, smooth at the base, with patches of bristly hair across the lower end, and on the smooth under side are a few scattered bristles. The fangs are short and strongly curved.

The *lip* is broader than long, widest at the base, narrowing to, and rounded at, the anterior margin. It reaches to more than half the height of the mandibles, which slope over it. These are rounded anteriorly, and the outer margin curves continuously to the insertion of the trochanter of the palps.

The *sternum* is convex, of a broad shield-shape, almost as wide as long, truncate in front, and narrowing to a point posteriorly between the not quite contiguous rear coxae.

The *abdomen* is ovate, broadest two-thirds of the distance from its base, where it is rounded and has a median longitudinal depression. The downlying flat hairs are slightly plumose, all pointing with their heads to the rear.

The *legs* are moderately fine and even in length, the second pair being only about one-fifth longer than the shortest of the other three pairs, the fourth is slightly longer than the first and third, but they do not vary much. The tarsal and rather thinner metatarsal joints are cylindrical. There are two pairs of long spines and one shorter on the under side of the tibia and metatarsus of each leg. They are rather thickly covered with the same downlying flat pointed hairs as the cephalothorax and abdomen, and a few upstanding bristles, also long upstanding spines.

The scopulae and claw-tufts on all feet are of the same type of flat pointed, not spatulate, bristles, shorter and more upstanding

than those on the other joints. They are not divided longitudinally as in *Misumena*. The inner of the pair of tarsal claws has about three rather long pectinations on the shaft curving with the curved point of the claw.

The *palpi* are short and fine, with hair and bristles as on the legs, and spines on the tibial joint.

The measurements (in millimetres) of the largest are as follows:—

	Long.	Broad.				
Cephalothorax...	$3\frac{1}{2}$		$\left\{ \begin{array}{l} 1\frac{1}{4} \\ 3 \end{array} \right.$ in front.			
Abdomen.....	5		$3\frac{1}{2}$			
Mandible.....	$1\frac{1}{4}$					
	Coxa.	Tr. & fem.	Pat. & tib.	Metat. & tars.		
Legs.....	1.	$3\frac{1}{4}$	$3\frac{1}{4}$	$3\frac{1}{4}$	=	$10\frac{3}{4}$
	2.	4	4	4	=	13
	3.	$3\frac{1}{4}$	$3\frac{1}{2}$	$3\frac{1}{4}$	=	11
	4.	$3\frac{1}{4}$	$3\frac{1}{2}$	$3\frac{3}{4}$	=	$11\frac{1}{2}$
Palpi	$\frac{1}{2}$	$1\frac{1}{4}$	1	1	=	$4\frac{1}{4}$

This species conforms to M. Simon's genus *Petricus* from South America, and is closer to his *P. niveus* than to any of Mr. Tullgren's species. It differs, however, from the former in its front row of eyes being very clearly recurved instead of slightly; the median are 3 diameters apart instead of one, and nearer to the lateral than to one another instead of equidistant; the lateral eyes of the front and rear rows about 4 diameters apart instead of $1\frac{1}{2}$; the area of the median quadrilateral equally broad in front and rear, instead of much broader in front. The front pair of legs are longer and the others shorter in proportion to the cephalothorax than in *P. niveus*.

There are nine females from various districts, apparently the same but differing in size of adults and brightness of colour.

OPILIONES.

Family GONYLEPTOIDÆ.

Genus SADOCUS Sor.

SADOCUS VALLENTINI, sp. n. (Pl. II. figs. 7-7c.)

Carapace yellow-brown mottled with black-brown anteriorly, nearly all dark brown at posterior end; eye-tuberle yellow in middle, black-brown at each side.

Trochanters yellow; other joints yellow mottled with black-brown; anterior ends of tarsi of rear two pairs yellow with yellow

claws. Hair generally pale yellow-grey. The under side of the abdomen is paler than the upper side, having more yellow and less dark mottling.

The *eye-tubercle* is oval, twice as broad as long, the eyes being at the extreme side edges. It is situated in the front half of the cephalic part, the portion in front of it being its own width and twice that distance behind.

The thoracic part of the *carapace* is slightly convex with a distinct marginal sulcus all round. There are small globular tubercles in the median area of the cephalic part, but not extending to the sides, reaching from the eye-tubercle to the rear margin. There are smaller sparsely scattered granulations on the second, third, and fourth divisions of the scutum, and a pair of tubercles on the latter. Behind this are four segmental divisions thickly covered with tubercles, succeeded by a posterior broader marginal area, also tuberiferous, which ends, in the female, in a median pointed process as long as the rear trochanters. In what appears to be the male this is wanting. On the under side of the carapace the flat coxal areas of the second and third pairs of legs extend to a narrow sternal depression, those of the first pair to round the mouth-parts. There is a small lower lip above the sternum and movable chitinous maxillæ unconnected with the coxae of the palps. A much larger upper lip is divided into two parts on the under side by a muscular double wall. On the under side of the tibial joint of the palp are three spinous processes on the outer margin, and four on the inner. On the tarsal joint of same are four spines alternately long and short on the outer side, and three on the inner side of the falk-sheath. The long, slightly curved, movable fang is about the length of the tarsal joint. The mandibles reach up to about the anterior end of the patellar joint of the palp. There are three equal teeth on the inside of the fixed claw, one large between two smaller on the movable claw. The coxal area of each of the fourth pair of legs is twice as broad as the median portion of the thorax lying between them. They extend along each side twice the length of the three anterior coxal areas. At the posterior end of this coxa a chitinous process projects from the outer corner as long as the breadth of the trochanter in the females, and twice that length in the males. Behind this is a round convex boss.

At the posterior end of the median area, lying between the fourth coxae, are the pulmonary apertures with oval convex lids, and on the inner side between these are a pair of oval hollow depressions.

The three anterior pairs of legs are of about the same diameter, rather slender, all without spines but covered with short hair. On the tarsal joint of the third and fourth pairs are two curved smooth claws. Tarsus 1 has five joints; tarsus 2 eight; tarsus 3 and 4 six each. The trochanteral joint of the fourth pair is as long as broad and thickly covered with spinous tubercles.

The femoral joint is thickly covered with long chitinous spinous processes, which in the male are twice as long as in the female. The patellar joint is enlarged and globular, the other joints are without spines but thickly covered with hair.

The measurements (in millimetres) are as follows :—

	Long.	Broad.
Cephalic } & Sternal }	part of scutum...	2 3
Abdominal do. do....	5	5
Mandibles	2	
	Coxal part. Tr. & fem.	Pat. & Metat. tib. & tars.
Legs.....	1. $\frac{3}{4}$ 3 2 3 = $8\frac{3}{4}$	
	2. 1 $3\frac{1}{2}$ $3\frac{1}{2}$ $2\frac{1}{2}$ $2\frac{1}{2}$ = 13	
	3. 1 $3\frac{1}{2}$ 3 4 = $11\frac{1}{2}$	
	4. 3 4 $3\frac{1}{2}$ 5 = $15\frac{1}{2}$	
Palpi	$1\frac{3}{4}$	$1\frac{1}{2}$ 1 = $4\frac{1}{4}$

This differs from *S. vitellinosulcatus* Sor. (believed to have come from S. America and described from a single female) in having a single terminal process above the anal tubercle at the posterior end of the abdomen, instead of a pair of quite small ones; in having the anterior edge of the scutum straight instead of two pointed processes in the middle; in having no spine on the femoral joint of the palpi and no pattern on the back of the abdomen, as well as in its smaller size. There is no process on the eye-tubercle.

One male, 6 females and 2 non-adult, found among decaying roots of ferns.

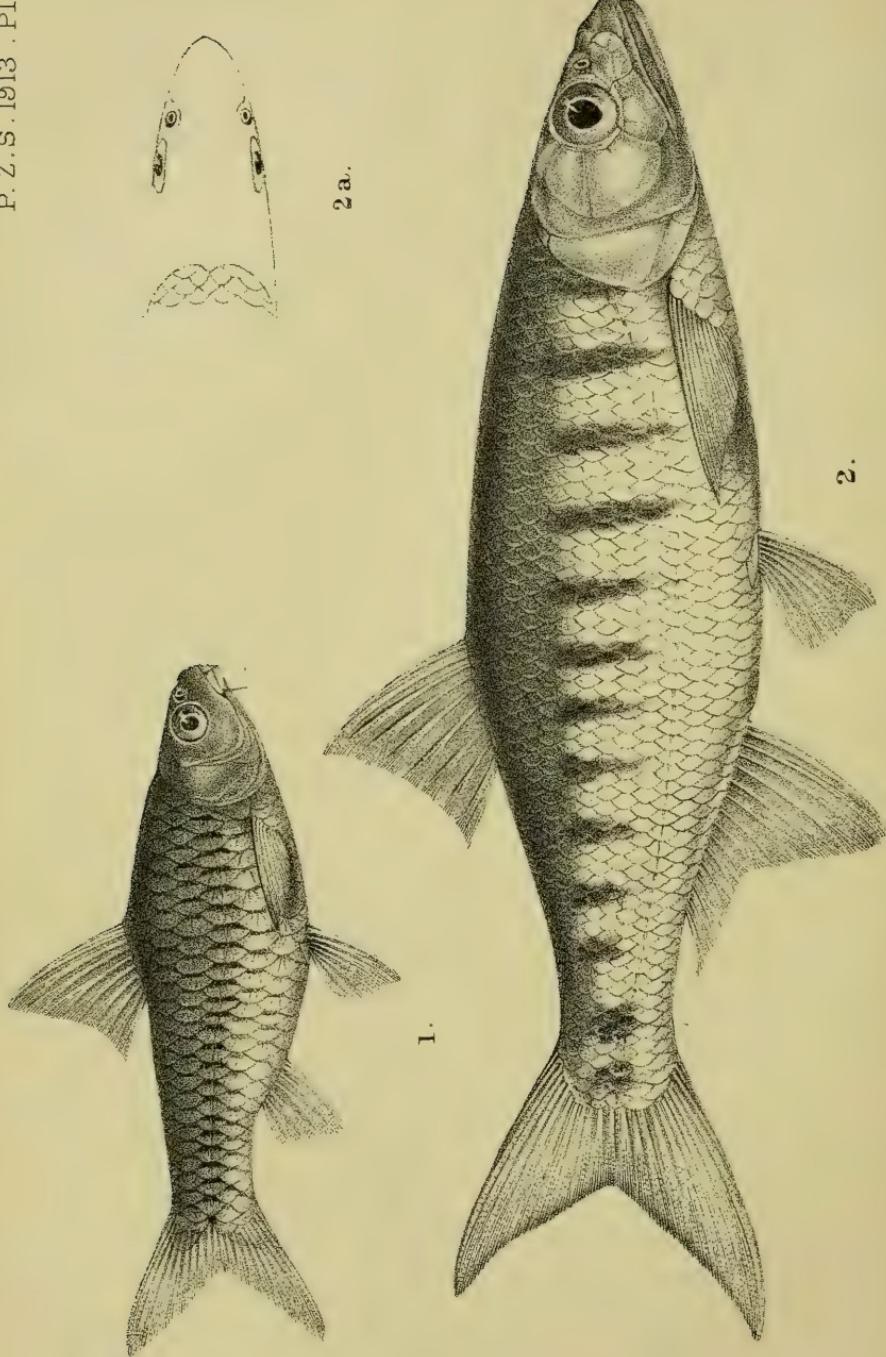
EXPLANATION OF THE PLATES.

PLATE I.

- Fig. 1. *Petricus signatus*, sp. n., $\times 3$. a. Eyes. b. Lip and maxillæ. c. Epigyne.
 2. *Emmenomma falklandica*, sp. n., $\times 2$. a. Eyes. b. Epigyne.
 3. *Araneus vallentini*, sp. n., nat. size. a. Underside of abdomen. b. Profile.
 c. Front of cephalothorax and eyes. d. Lip and maxillæ. e. Epigyne.
 4. *Araneus globiger*, sp. n., nat. size, ♂. a. Eyes. b. Male palp from side.
 c. Male palp from underneath. d. Tibia II. e. Coxa I.

PLATE II.

- Fig. 5. *Philisca colulata*, sp. n., $\times 2$. a. Eyes. b. Mandible. c. Epigyne.
 d. Spinnerets.
 6. a. Eyes of *Tetragnatha insulata*, sp. n. b. Underside of mandible, ♂.
 c. Fore-end of mandible from above. d. Male palp. e. Epigyne.
 7. *Sadocus vallentini*, sp. n., $\times 2$. a. Underside of carapace. b. Mouth parts.
 c. Mandible and palp.



1. BARBUS SPURRELLI. 2. BARILIUS MACROSTOMA.

3. Descriptions of Three new Fishes discovered in the Gold Coast by Dr. H. G. F. Spurrell, M.A., F.Z.S. By G. A. BOULENGER, F.R.S., F.Z.S.*

[Received October 28, 1912 : Read November 12, 1912.]

(Plate III.†)

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Dr. Spurrell, who for some years has enriched our collection of living animals with many examples of Reptiles from the Gold Coast, has lately turned his attention to Fishes, and has presented two small collections to the British Museum. Among them I have found examples of what appear to me three new species. These fishes are from the vicinity of Bibianaha, near Dunkwa, between the watersheds of the Tano and Ankobra Rivers. Notes on the fresh coloration have been supplied by Dr. Spurrell.

BARBUS SPURRELLI, sp. n. (Pl. III. fig. 1.)

Depth of body 3 to $3\frac{1}{2}$ times in total length, length of head $3\frac{1}{2}$ to $3\frac{2}{3}$ times. Snout rounded, as long as eye, $3\frac{1}{3}$ to $3\frac{1}{2}$ times in length of head, interorbital width $2\frac{3}{4}$ to 3 times; mouth subinferior; lips moderately developed; two barbels on each side, posterior as long as eye and twice as long as anterior. Dorsal III 8, equally distant from centre or anterior border of eye and from root of caudal, border feebly concave; last simple ray not enlarged, as long as head. Anal III 5, not reaching caudal. Pectoral $\frac{4}{5}$ length of head, reaching ventral; base of latter below anterior rays of dorsal. Caudal peduncle 1 to $1\frac{1}{3}$ times as long as deep. Scales radiately striated, 24–26 $\frac{31}{32}$, 2 between lateral line and ventral, 10 or 12 round caudal peduncle. Greenish silvery, darker on the back, the scales dark-edged or with a dark base; this dark base often more marked on the scales of the lateral line, which may be further obscured by black dots, forming an ill-defined dark lateral band; fins greyish.

Total length 75 mm.

Several specimens.

This species comes very close to *B. ablabes* Blkr.

BARILIUS MACROSTOMA, sp. n. (Pl. III. figs. 2, 2 a.)

Depth of body equal to length of head, $3\frac{2}{3}$ times in total length. Head $2\frac{1}{2}$ times as long as broad; snout pointed, projecting beyond mouth, $1\frac{2}{3}$ times as long as eye, which is $4\frac{1}{2}$ times in

* By permission of the Trustees of the British Museum.

† For explanation of the Plate see p. 53.

length of head, $1\frac{1}{2}$ times in interorbital width; mouth extending nearly to below posterior border of eye; no barbels; second suborbital deep, extending posteriorly to vertical of posterior border of eye; naked space between praeperculum and suborbital about $\frac{1}{4}$ diameter of eye. Gill-rakers few and very rudimentary. Dorsal III 8, originating at equal distance from occiput and from root of caudal; posterior third of its base above anal; anterior rays longest, a little less than $\frac{2}{3}$ length of head. Anal III 14, notched, anterior lobe rounded. Pectoral pointed, $\frac{2}{3}$ length of head, not reaching ventral, which is much shorter and reaches vent. Caudal crescentic when fully spread out. Caudal peduncle $1\frac{3}{4}$ times as long as deep. Scales with radiating striae, 52 $\frac{11\frac{1}{2}}{6\frac{1}{2}}$, 3 between lateral line and ventral, 16 round caudal peduncle. Silvery, with 13 or 14 dark bars on the side of the body above the lateral line; dorsal fin greyish, anal reddish, caudal red with a black edge.

Total length 155 mm.

A single specimen.

This species is closely allied to *B. senegalensis* Stdr., and *B. loati* Blgr., both of which occur in West Africa. It agrees with the former in the extension of the dorsal over the anterior third of the anal and in the larger eye, but differs in the longer mouth and in the lower number of scales in the lateral line (52 instead of 59–63); with the latter it agrees in the number of scales in the lateral line, but the larger eye, the longer mouth and the position of the origin of the anal with regard to the dorsal suffice to separate it; and, finally, the number of scales in a transverse series ($\frac{11\frac{1}{2}}{6\frac{1}{2}}$ instead of $\frac{9\frac{1}{2}-10\frac{1}{2}}{4\frac{1}{2}-5\frac{1}{2}}$) distinguishes it from both its nearest allies.

FUNDULUS SPURRELLI, sp. n.

Depth of body 4 to $4\frac{1}{3}$ times in total length, length of head $3\frac{1}{3}$ to $3\frac{3}{4}$ times. Head flat above; snout short and broad, shorter than eye; mouth directed upwards; lower jaw projecting; eye $3\frac{1}{2}$ times in length of head, $1\frac{2}{3}$ times in interorbital width; space between eye and lip about $\frac{1}{5}$ diameter of former. Dorsal 13–14, originating at equal distance from head and from base of caudal, longest (posterior) rays $\frac{2}{3}$ to $\frac{3}{4}$ length of head. Anal 15–16, originating slightly in advance of dorsal. Pectoral nearly $\frac{2}{3}$ length of head, not quite reaching base of ventral, which is small and midway between end of snout and base of caudal. Caudal rounded in the female, subtruncate in the male. Caudal peduncle longer than deep. 29–31 scales in longitudinal series, 24–26 round body in front of ventrals; lateral line indicated by a more or less complete series of pits. Male pale yellowish green, with numerous narrow, often paired, vertical bars of dark carmine; sides of head metallic green, variegated with carmine; gular (branchiostegal) region of a dark, rich blue; pectoral fin whitish, with an oblique crimson streak, ventral with red tip; vertical fins grey, dotted

with carmine and broadly edged with yellow or orange, the yellow bands occupying the upper and lower fourths of the caudal. Female paler, more translucent, at times pinkish; fins white, dorsal and anal dotted with carmine.

Total length 42 mm.

Several specimens.

Allied to *F. gardneri* Blgr.

This species will be figured in the forthcoming third volume of the British Museum Catalogue of African Freshwater Fishes.

EXPLANATION OF PLATE III.

Fig. 1. *Barbus spurrelli*.

2. *Barilius macrostoma*.

2a. " " Head from above. Natural size.

4. On some Parasites of the Scoter Duck (*Oedemia nigra*), and their Relation to the Pearl-inducing Trematode in the Edible Mussel (*Mytilus edulis*). By H. Lyster Jameson, M.A., D.Sc., Ph.D., and William Nicoll, M.A., D.Sc., M.D.

[Received October 18, 1912: Read November 12, 1912.]

(Text-figures 11 & 12.)

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Of the many questions connected with the formation of pearls in the common Edible Mussel (*Mytilus edulis*) the identity and life-history of the pearl-inducing organism is one of the most important. It was shown ten years ago by Jameson (1902) that the agent in this particular case is the larva of a parasitic Trematode, which, instead of secreting a cyst of its own, as is usual with such larvæ, stimulates the mussel to form around it a sac of epidermal cells. These cells possess the same physiological properties as the outer shell-secreting epidermis, and eventually, on the death of the Trematode larva, secrete concholin and calcareous salts, which, deposited in concentric layers around the remains of the worm, become the pearl. Attempts were made by Jameson to trace the life-history of this parasite, but the difficulties in the way of working out the complete life-cycle of digenetic Trematodes are considerable, and the results obtained by him in 1902 have not been accepted as entirely conclusive.

With regard to the parasite in *Mytilus*, the two main questions to be solved were: (1) Whence does it come? and (2) Whither does

it go? From a consideration of Trematode development in general, it was obvious that these larvae in *Mytilus* must have passed a previous stage, as a sporocyst or redia, in some other molluscan host, and it was equally obvious that they were destined to become adult in some final vertebrate host, to be sought among the animals that eat the mussel.

With regard to the earlier part of the life-history, Jameson was struck by the occurrence in *Tapes decussatus*, which lives associated with the pearl-bearing mussels in the harbour of Billiers (Morbihan), Brittany, of sporocysts containing *Cercarie* closely resembling those in *Mytilus* and differing from them chiefly in size. Jameson subsequently found similar sporocysts in a different situation in the common Cockle (*Cardium edule*) on the pearl-bearing mussel-beds at Piel, Lancashire, and these have since been rediscovered by Lebour (1906) and Nicoll (1906). The occurrence of these sporocysts in *Cardium* is of particular interest in view of the fact that the cockle, as a rule, lives in close association with the mussel and is on that account a not unlikely intermediate host for the mussel parasite.

Herdman (1903-6) failed to find this parasite in Piel cockles, and seems to have doubted Jameson's assertion that it occurred there; but we have found it over and over again in cockles both from the original station at Piel, and from the cockle-bed at Foulney in the same neighbourhood.

Infection-experiments were undertaken by Jameson in 1901, in order to prove the transference of the parasite from *Tapes* to *Mytilus*, but although he claimed success in these experiments, they are still open to the objection that some at least of the mussels used were already infected before the experiment was undertaken *.

Pending the results of further experiments, there are only the structural characters of the two larval forms to go upon. Morphologically there is a very close agreement between the cercaria in *Cardium* and that in *Mytilus*. They both agree in having the oral sucker not more than one-fifth of the body-length, and in its being not more than one-third as large again as the ventral sucker. In both the pharynx is comparatively large. The differences which exist are small. For instance, the oral sucker in the *Mytilus* cercaria is relatively larger than that in the *Cardium* cercaria; the ventral sucker is larger in the former in proportion to the oral and it is slightly nearer the posterior end of the body instead of, as might have been expected, further forward. Again, the oesophagus is shorter and the diverticula longer. These discrepancies, although minute, are sufficient to give pause in too hastily concluding that the two forms belong to one and the same species.

With regard to the final host of this parasite, there can be little doubt but that Jameson was right in supposing it to be one of the

* [I am at present repeating these experiments, with the aid of a Government Grant from the Royal Society.—H. L. J.]

mussel-eating ducks, such as the Scoter and the Eider; but the form he figured as the adult in 1902 from the Common Scoter, which he referred to *Gymnophallus (Lecithodendrium) somateriae*, and which we are now describing below under the name *G. oedemiae*, is certainly not the adult of the larva which occurs in *Mytilus*, but is a much smaller species *.

In order to reconcile the small size of the larvæ which he found in the Scoter at Billiers in 1902 with the larger dimensions of the larvæ in the mussel, Jameson was obliged to have recourse to an unlikely hypothesis. This was commented on by Odhner, who suggested that Jameson had probably encountered a mixture of two species, one probably being *G. bursicola* and the other a new species of the same genus. As the present investigation will show, the latter part of Odhner's supposition was correct; while, with regard to the former, until further specimens from Billiers can be examined, it is impossible to say whether the larger examples observed by Jameson at that station were *G. bursicola* or *G. dapsilis*.

Since the publication of Jameson's paper, two species, namely *Gymnophallus bursicola* Odhner and *G. dapsilis* Nicoll, have been suggested as the possible adult form. Before the discovery of the second of these species Odhner (1904) gave it as his opinion that the probable adult was *G. bursicola*, a parasite of the Bursa Fabricii of the Eider Duck (*Somateria mollissima*). At the same time he stated that a larva identical with that in *Mytilus* occurs in *Saxicava rugosa* in the Arctic regions. At that time there could be little question as to the probable correctness of his view, for no other known species was so likely to be the adult of the parasite in *Mytilus*. The discovery by Nicoll (1907) in the Scoters of a second bursicolous *Gymnophallus* closely resembling, yet distinct from, *G. bursicola*, showed that Odhner's conclusions could not be accepted without further study, for *G. dapsili* appears to have even stronger claims than *G. bursicola* to be considered the adult of the larva in the Piel pearl-bearing *Mytili* †.

The two chief facts in favour of such a view are that the sizes of the suckers and the position of the ventral sucker, in the Piel pearl-inducing Trematode, correspond more closely with those in *G. dapsilis*, while the firm brittle consistency of the body reminds one more of *G. dapsilis* than of the softer *G. bursicola*. The position of the testis in relation to the ventral sucker is also a feature of some moment. It is, of course, quite possible that two closely allied Trematodes are concerned with pearl-formation in *Mytilus*—the one derived from *Tapes*, the other from *Cardium*,—and it may be that the adults of these two species are respectively *G. bursicola* and *G. dapsilis*.

Jameson foresaw that it would be necessary to prove in some

* [I distinctly remember the occurrence of a small number of larger *Gymnophallus* in the Billiers *(Edemiae*, though it did not occur to me at the time that more than one species might be present. I referred them all to the only species then known to me, *G. somateriae*.—H. L. J.]

† We have not so far had an opportunity of re-examining the larvæ found in the Billiers mussels.

conclusive fashion the correctness of his views in regard to the life-history of the pearl-forming Trematode in *Mytilus*, and towards that end an endeavour was made in 1901 to perform feeding-experiments with a Pochard (*Fuligula ferina*), the only likely diving duck which was available at the time. These experiments were unsuccessful.

It was in continuance of this work that the present investigation was undertaken. Arrangements were made* to obtain some live Scoters (*Oidemia nigra*) and have them fed upon mussels infected with the pearl-inducing cercariae. Three Scoters were purchased on our behalf by the Zoological Society from D. G. Schuijl, of Rotterdam, who stated that they were all caught on the Zwarte Water, in the province of Overijssel. In addition, four dead Scoters, stated to come from the same locality, were kindly sent to us for examination by the Superintendent of the Brighton Aquarium. With one exception, these four birds were found to be heavily infected with intestinal parasites, including a considerable number of *Gymnophalli*. These will be referred to later. Of the three live Scoters, which were housed in the Society's Gardens, one died shortly after arrival, and was found to harbour numerous specimens of *Tocotrema concavum* and immature Cestodes in its intestine. The second Scoter was removed to the Lister Institute with the object of making a feeding-experiment, but it died within 24 hours. Its intestine contained only a few immature Cestodes. The third was kept from 8th to 24th December, 1911, when the experiment was started. It was fed at intervals with mussels from the beds at Foulney, near Piel, which were infected with the pearl-inducing *Gymnophallus*. Altogether about 1000 mussels were given to it. Check-examinations of samples of these mussels showed that out of 78 mussels 32 were infected, the number of live *Gymnophalli* being 64. On February 27th, 1912, the bird was killed and thoroughly examined. The only parasitic worms present were a few immature tapeworms in the intestine and two specimens of *Metorchis xanthosomus* in the gall-bladder.

It is difficult to draw any satisfactory conclusion from the result of this experiment. At first sight the most obvious inference would appear to be that the larva in *Mytilus* does not become adult in *Oidemia*, but in some other host. This inference, however, is not without objection, for, quite apart from the evidence furnished by the close resemblance between the parasite in the mussel and in the duck, other factors may require to be taken into consideration—for instance, the somewhat unnatural mode of feeding, the unsuitability of the season, the effect of captivity, and so forth. In this connection, the complete absence of other Trematodes from the intestine is significant, as suggesting that the intestine may possibly have been cleared of parasites as a result of digestive derangements following on change of

* [Thanks to a grant from the Government Grant Committee of the Royal Society.—H. L. J.]

food. It is, however, useless to speculate on these matters, and for the present we are content to record the negative result of this particular experiment.

Our main object in submitting the present communication is to give an account of the new species of *Gymnophallus* which were encountered in the course of examining the Scoters, and also to note the occurrence of a few other Trematode parasites which have hitherto not been recorded from this host. Nicoll (1907) gives the following list of Trematode parasites from *Ædemia nigra* examined at St. Andrews:—

<i>Gymnophallus dapsilis</i> Nicoll.	Bursa Fabricii.
<i>Psilostomum brevicolle</i> Creplin.	Intestine.
<i>Spelotrema pygmaeum</i> Levinson.	Intestine.

The following have been recorded by other authors:—

<i>Psilochasmus oxyurus</i> Creplin.	Intestine.
<i>Echinostomum revolutum</i> Froelich.	Intestine.
<i>Monostomum</i> sp.	Respiratory tract.
<i>Strigea tarda</i> Steenstrup.	Intestine.

In the course of our examination we found the following:—

<i>Psilostomum brevicolle</i> Creplin.	Intestine.
<i>Tocotrema concavum</i> Creplin.	Intestine.
<i>Levinsoniella brachysoma</i> Creplin.	Intestine.
<i>Metorchis xanthosomus</i> Creplin.	Gall-bladder.
<i>Gymnophallus dapsilis</i> Nicoll.	Intestine.
<i>Gymnophallus bursicola</i> Odhner	Bursa Fabricii.
<i>Gymnophallus ædemiae</i> , sp. n.	Intestine.
<i>Gymnophallus affinis</i> , sp. n.	Intestine.
<i>Gymnophallus macroporus</i> , nom. nov.	Intestine.
<i>Gymnophallus ovoplenus</i> , sp. n.	Intestine.
<i>Catatropsis verrucosa</i> Froelich.	Bursa Fabricii.

This makes a total of 15 distinct species from this single host, of which 9 are here recorded for the first time. Such a wealth of varieties of Trematode parasites in a single host is rather remarkable*.

The new species which we are describing were all obtained from the Scoters supplied by the Brighton Aquarium. The birds originally came from the same quarter as those purchased through the Zoological Society, and it is rather striking that they should have been so heavily infected, while the others were almost free from Trematodes.

GYMNOGRAPHALLUS ÆDEMILÆ, nom. nov.

= *Lecithodendrium somateriae* Jameson, 1902 (*ex parte*).

This was the least common of the four species, and occurred in

* [To the list must be added *Paramonostomum alveatum* Mehlis, which was obtained from a Scoter (*Ædemia nigra*) which died in the Society's Gardens on Nov. 19th, 1911.—W. N.]

only two of the birds examined. It is the adult form depicted by Jameson (1902, pl. xvi. fig. 11) and to which the greater part of his description (pp. 159–160) applies.

The body is somewhat flat and oval, with pointed extremities. Its length is 19–25 mm. and its maximum breadth is usually a little more than half the length. The cuticle is entirely covered with minute spines. The oral sucker measures 0.30–0.37 mm. in diameter and the ventral sucker 0.24–0.32 mm., the ratio being approximately 6 : 5. The ventral sucker is situated at a distance of 11–15 mm. from the anterior end, the distance being about three-fifths of the body-length.

The pharynx is contiguous with the oral sucker and is about 0.17 mm. long. It is followed by a narrow oesophagus which may be nearly twice as long as the pharynx. The intestinal diverticula diverge fairly widely and barely reach the middle of the body. The excretory vesicle consists of a very wide main stem and two long branches, which nearly reach the oral sucker.

The testes lie some distance behind the ventral sucker, but nearer it than the end of the body. They are small and irregularly globular. The vesicula seminalis is situated over the left side of the ventral sucker, usually a little in front, but sometimes extending to the posterior border of the sucker. From it issues a short pars prostatica, of the usual *Gymnophallus* type, opening on the anterior lip of the sucker.

The ovary lies on the right side, on the same level as the ventral sucker, and it is nearly as large as the sucker. The yolk-glands are situated over the anterior half of the ventral sucker. They are somewhat irregular. The uterus lies almost entirely in front of the ventral sucker, and extends forwards almost to the oral sucker, filling up most of the anterior part of the body. The eggs, which usually number 30–100, measure 0.18–0.20 mm. in length and 0.013–0.014 mm. in breadth.

GYMNOPHALLUS AFFINIS, sp. n. (Text-fig. 11.)

This species, although about the same size as *G. aedemiae*, is at once distinguished from it by the large size of the oral sucker and by the disposition of the uterus. It measures 2–25 mm. in length and 11–13 mm. in breadth, the body being flat and oval. The ends are not usually so pointed as in the previous species.

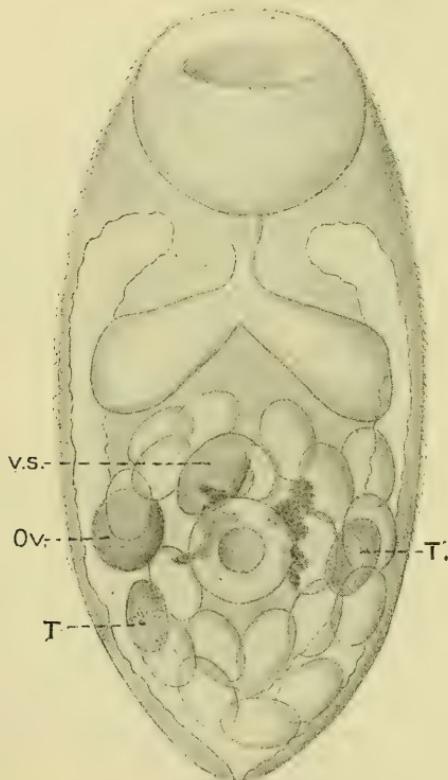
The oral sucker has a transverse diameter of 0.65–0.85 mm. The ventral sucker is very much smaller, measuring only 0.30–0.45 mm., and the ratio is usually about 2 : 1. The ventral sucker is situated 16–18 mm. from the anterior end, i.e., a little more than two-thirds of the body-length.

The pharynx, which is contiguous with the oral sucker, measures 0.15–0.18 mm. in length by 0.12–0.17 mm. in breadth. It is followed by an oesophagus of about the same length. The intestinal diverticula diverge very widely and are usually much dilated. As a rule, they do not reach the middle of the body

The excretory vesicle is V-shaped, the main stem being very short.

The testes are two elongated oval bodies, measuring about $\cdot025 \times \cdot014$ mm. That on the left lies on the same level as the ventral sucker, the one on the right being somewhat behind. The vesicula seminalis lies adjacent to the anterior border of the ventral sucker, and from its anterior end issues the pars prostatica.

Text-fig. 11.



Gymnophallus affinis, sp. n. Ventral view, $\times 400$.

Ov. Ovary. T. Testes. V.S. Vesicula seminalis.

The ovary is considerably larger than the testes, measuring $\cdot027 \times \cdot023$ mm., and is more nearly globular. It is situated almost immediately in front of the right testis and on the level of the anterior border of the ventral sucker. The yolk-glands lie over the anterior half of the ventral sucker. Each gland consists of a somewhat crescentic mass of very irregular contour, the concavities of the crescent being directed outwards.

The uterus lies mostly behind and to the left side of the

ventral sucker. It seems to form a single loop, starting from the ovary, passing behind the ventral sucker and up along the left side of the body to some distance in front of the sucker, then returning in the same way. The eggs are of conspicuously large size, measuring $0.021-0.028 \times 0.013-0.018$ mm.

There were a considerable number of much smaller specimens ($0.13-0.19$ mm. in length) bearing a close resemblance to the foregoing. Even the smallest of them, measuring only 0.135 mm. in length, was fully mature and contained about a dozen large eggs. All intermediate sizes between this and 0.2 mm. were observed. It is difficult to decide whether these small specimens are the same as *Gymnophallus affinis* or whether they represent a distinct species. The differences, apart from the difference in size, are not very easy to detect. The body is altogether more plump and the various organs more packed together. The suckers are relatively larger. The intestinal diverticula extend past the middle of the body and are in contact with the ovary and the vesicula seminalis. The yolk-glands are slightly further back and appear to be partly fused or at any rate very close together, while the uterus extends forwards to the oral suckers on the left side. These differences, although noticeable, do not appear sufficiently constant to warrant the creation of a further new species, so that for the present we shall content ourselves with noting the existence of these smaller forms.

GYMNOHALLUS MACROPORUS, sp. n. (Text-fig. 12.)

This is the largest of the four species, and measures $0.4-0.5$ mm. in length by $0.14-0.23$ mm. in maximum breadth. The greatest breadth is across the middle of the body, but is not very much greater than that of the oral sucker, and this gives the animal a very characteristic shape. The lips of the sucker are usually everted and project well beyond the sides of the body. From the anterior end the body tapers gradually towards the pointed tail, though there is usually a slight inflation a little in front of the ventral sucker. The oral sucker has a transverse diameter of $0.14-0.17$ mm., the ventral sucker $0.065-0.075$ mm. The ratio is generally about $9:4$. The ventral sucker is situated at a distance of about $0.3-0.4$ mm. from the anterior end of the body, *i.e.* about three-fourths of body-length.

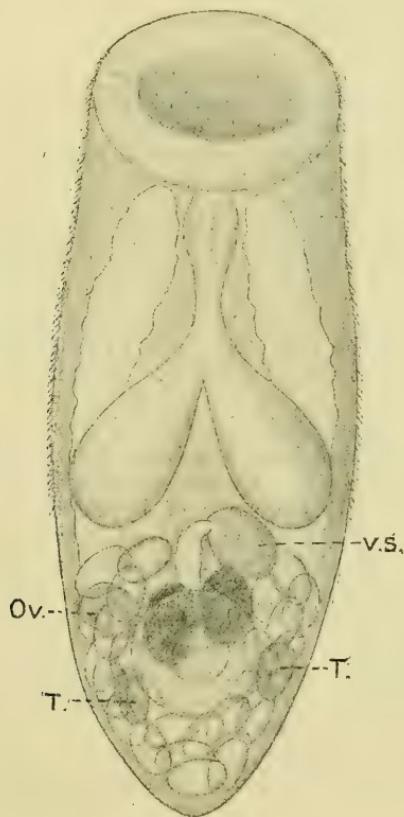
Almost contiguous with the oral sucker is a comparatively large pharynx measuring 0.040×0.035 mm. The oesophagus is slightly longer than the pharynx, measuring 0.05 mm. The intestinal diverticula are usually moderately distended and form an acute angle with each other. Their ends reach well past the middle of the body.

The excretory vesicle is V-shaped and the limbs are frequently enormously distended, compressing the intestine and giving the anterior part of the body a hollow appearance.

Owing to the close packing together of the eggs the ovary and testes were extremely difficult to discern. They appear, however,

to have much the same disposition with regard to the ventral sucker as in *Gymnophallus affinis*, the ovary lying on the right at the level of the anterior border of the sucker, the right testis being at the posterior border and the left testis occupying an intermediate level. The yolk-glands differ from those in *G. affinis* in being much more compact, their outlines, in fact, being quite oval. They usually lie over the anterior half of the ventral sucker or a little in front of it.

Text-fig. 12.



Gymnophallus macroporus, sp. n. Ventral view, X 250.

Ov. Ovary. T. Testes. V.S. Vesicula seminalis.

The vesicula seminalis lies immediately in front of the yolk-glands, sometimes median, at other times displaced laterally. From its anterior end issues a short wide pars prostatica, running down towards the ventral sucker. The uterus is disposed around the ventral sucker and does not extend in front of the intestinal

diverticula. The eggs do not show the same tendency to be massed towards the left side as is seen in *G. affinis*. They are of relatively enormous size, measuring $0.029\text{--}0.034 \times 0.015\text{--}0.020$ mm., the average being 0.032×0.0175 mm. There are usually about 30–100 eggs.

Gymnophallus ovoplenus, sp. n.

This fourth species, which is undoubtedly distinct from all the others, was characterised by its extremely minute size and by the enormous overgrowth of the uterus, which completely filled the body. The numerous eggs seen in the smallest specimen entirely obscured the other organs, rendering a description of the internal anatomy impossible. On that account, it is to some extent a matter of conjecture as to whether the species actually belongs to the genus *Gymnophallus* or not, but from its general appearance there seems little doubt that it does.

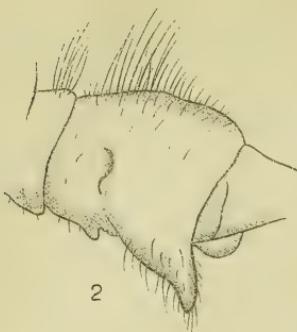
It is a very plump, subcylindrical species with somewhat pointed ends. The length is $0.11\text{--}0.13$ mm. and the maximum breadth about 0.07 mm. The oral sucker does not measure more than 0.024 mm. in diameter, and it is not much larger than the ventral sucker (0.019 mm.), which is situated about two-thirds of the body-length from the anterior end. The uterus fills the body, except for a small space at the tip of the tail which usually remains free. Anteriorly the eggs are packed tightly around the oral sucker, rendering it almost invisible. They measure $0.016\text{--}0.019 \times 0.011\text{--}0.012$ mm.

It was at first thought that these specimens were simply young forms of either *G. affinis* or *G. oedemiae*, but it seems impossible that such can be the case. Even when the animal is only 0.12 mm. long the uterus attains a stage of hypertrophied development which is never seen in either of the other species even when twice as large. It might be conjectured that either or both of these species may become prematurely ripe and that egg-production falls off later. This, however, is a hypothesis which has nothing to support it. Moreover, as has already been mentioned, specimens measuring 0.13 mm. and closely resembling *G. affinis* have been found, and in them the uterus occupied only a relatively small proportion of the body.

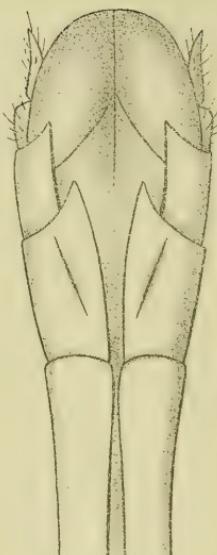
Judging by the relative sizes of the suckers, this species is more closely allied to *G. oedemiae* than to *G. affinis*.

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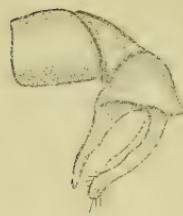
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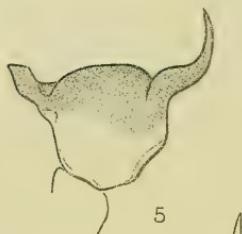
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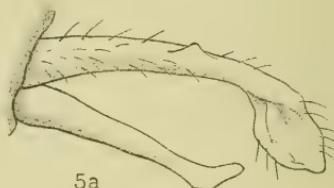
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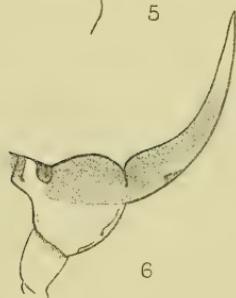
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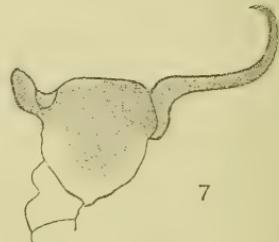
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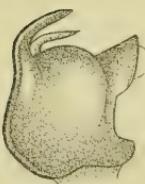
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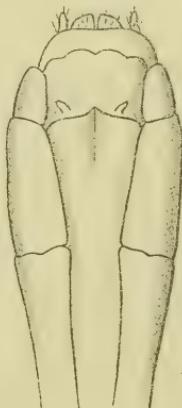
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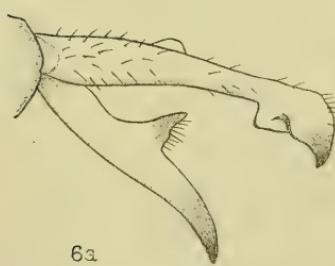
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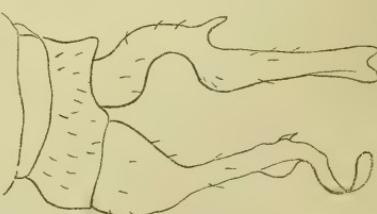
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5. Contributions to a Study of the Dragonfly Fauna of Borneo.—Part I. The Corduliinæ: The Genus *Amphicnemis*: The Legion Protoneura. By F. F. LAIDLAW, M.A., F.Z.S.

[Received October 17, 1912: Read November 12, 1912.]

(Plate IV.*)

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ANISOPTERA.

CORDULIINÆ.

The most recent classification of this subfamily is that suggested by Tillyard†. He proposes to arrange the various genera composing it into four groups, as below:—

- i. Eucordulina ;
- ii. Idocordulina ;
- iii. Macromina ;
- iv. Synthemina.

Of these groups i., iii., and iv. are on the whole well characterised, the larvæ are moderately well known, and the geographical

* For explanation of the Plate see p. 79.

† Tillyard, Proc. Linn. Soc. N. S. W. 1912, xxxvi. 2, pp. 381–386.

distribution of the genera fits in well with the proposed arrangement. The second group, Idocordulina, however, is not in so satisfactory a condition. The species referred to it are mostly rare, largely tropical in distribution and hence their larval forms are but little known, and the characters of their venation are very diverse. In consequence there is reason to suspect that the group will prove not to be a natural one, although as no criterion is yet available for a better grouping of the genera referred to it, needs must for the present that it be retained in its existing form.

The group Synthemina, being purely an Australian one, does not concern us here.

Of each of the other three Borneo has representatives.

Writing in 1899, Krüger * was able to record only one Corduline for Borneo, and but fourteen for the whole Malay Archipelago.

Martin in his Monograph of the Corduliinæ, in the "Collections Zoologiques du Baron Edm. de Sélys Longchamps, Fasc. xvii." published in 1906, gives a total for the island of seven.

In the present paper, thanks to the amount of material sent to me from the Sarawak Museum by Mr. Moulton, the Curator, I am able to give the following list of species referable to this subfamily :—

Eucordulina :

Hemicordulia assimilis Sélys.

Idocordulina :

Metaphya micans Laidlaw.

Idionyx dohrni borneensis, subsp. n.

Macromina :

Macromia cincta Ramb.

„ *borneensis* Krüger.

„ *gerstaeckeri* Krüger.

„ *cingulata* Ramb.

„ *westwoodi* Sélys.

„ sp. ?

Epophthalmia australis Hagen.

„ *vittigera* Ramb.

One may, with tolerable confidence, predict additions to this list in the future.

Group i. EUCORDULINA.

1. *HEMICORDULIA ASSIMILIS* Sélys.

M. Martin has very kindly examined a male of this species for me and determined its identification. It is new to the Bornean

* Krüger, Stettin, Ent. Zeit. 1899, pp. 321-338.

fauna, having hitherto been met with in the Celebes, New Guinea, and the Solomon Islands.

The bulk of the genera referred to the Eucordulina group are massed in the Holarctic and in the Australian regions; with a few species in Extra-tropical S. America, and outliers in the Oriental region, the Seychelles, and Madagascar. On the whole the distribution agrees fairly closely with that of the Coniferae, and suggests that the two groups must be of approximately equal geological age.

Tillyard * has pointed out that the Australian genera are not to be regarded as more primitive than those of the northern hemisphere but show specialisation along lines of their own. *Somatochlora*, perhaps the most primitive, is bi-polar.

[Note.—In defining the Eucordulina, I believe that stress should be laid on the convergence of M_4 and Cu_1 in the front wing as a character especially marking the group. Accordingly I refer to the group all the genera included by Williamson † in his group i., adding to them *Cordulephya* and perhaps *Hesperocordulia*, the latter in deference to Tillyard's views, but I would exclude from it *Oxygastra* and the genera referred by Williamson to his groups ii. and iii.]

Group ii. IDOCORDULINA.

As I have already remarked, I do not look on this group as satisfactorily defined at present. Here I use it to hold those genera which do not, in my opinion, fit into the Eucordulina on the one hand nor yet into the Macromina on the other. These are genera which fall into groups ii., iii., iv., of Williamson's classification. Whether such genera will not ultimately be found to fall into one or more groups of equal value with the Eucordulina and Macromina I cannot now conjecture.

2. METAPHYA MICANS Laidlaw ‡. (Pl. IV. figs. 1-3.)

1 ♀. Matang Rd. §, 3.10.10.

Length of hind wing 23 mm., of abdomen 20 mm.

The female is more brilliantly coloured than the male, and is amongst the few Cordulines which have really brightly coloured wings. It agrees closely in proportions and in details of venation with the male.

The membranule is large and uniformly grey. This is also the case with the male. By an error I described it as having the upper third of the membranule white, the lower part dark brown. This description should apply to the single cell forming the anal triangle of the male.

* Tillyard, *loc. cit.*

† Williamson, Ent. News, Nov. 1908, pp. 428-434, pl. xviii.

‡ Laidlaw, Sarawak Mus. Journ. No. 2, 1912, pp. 65-67, pl. i.

§ All localities mentioned in this paper are in Sarawak, North-west Borneo.

In the female both pairs of wings have a smoky tinge all over them, most marked towards the apices. Further, the base of the fore wings has a rich red-brown tint, best marked in the sub-median space and in the sub-costal space, extending as far as the level of the second antenodal. The base of the hind wing has, too, a darker colour, except along the anal margin beyond the level of the anal angle, but on this wing the colour is for the most part of a dark brownish black (very similar to the colour on the wings of a *Rhyothemis*) with a metallic glaze, except that the median and cubital spaces have only the transparent red-brown tint of the base of the fore wing. The dark colour extends as far as the fourth antenodal nerve, and posteriorly has a regularly curved margin. Body-colour similar to that of the male. Upper surfaces of head and thorax metallic blue-green, abdomen shiny black, under surface of thorax and base of legs dark brown, the rest of the legs black.

The abdomen has been flattened and, especially at its distal extremity, distorted. It does not show quite so distinct an expansion of segments 7, 8, 9 as does the male; none the less there is a distinct enlargement.

The structure of these terminal segments is worth remark. Segment 8 is about $\frac{3}{2}$ the length of 9. Its lateral plates are produced ventrally and posteriorly into a pair of pointed spur-like projections. The lateral plates of 9 have a similar arrangement on a smaller scale.

The ventral plate of 8 is long, produced backwards to the level of the end of 9 at least, its posterior margin running to a median acute angle. It appears to fuse with the ventral plate of 9, which is produced backwards beyond the level of the tip of the abdomen and has exactly the shape of a spoon, with the concavity lying upwards. The ventral plates of both 8 and 9 have a median longitudinal keel. Segment 10 is so much crushed that it is impossible to discuss it. The appendages are small, and reach about to the level of the end of the spoon.

Neither in general organisation nor yet in the structure of the genital appendages does *Metaphya* appear to show particular kinship with *Idionyx*. I figure (Pl. IV. fig. 4) for comparison with the terminal segments of *Metaphya*, an outline drawing of the same part of a female of *Idionyx dohrni* Krüger from the Peninsula of Malacca (Skeat Expedition). The anal appendages of the male *Idionyx* distinctly approximate to the type found in *Macromia*, whilst those of *Metaphya*, which I also figure here, are very different.

I have not been able to examine specimens of the Tropical American *Gomphomacromia paradoxa*. In appearance, judging from Martin's figure *, there are grounds for considering relationship between it and *Metaphya* fairly close. From de Sélys's

* Martin, *op. cit.* pl. ii. fig. 9.

description of the anal appendages, in neither sex do these bear any very marked resemblance to those of *Metaphya*.

The genus *Idionyx*, hitherto unrecorded from Borneo, is represented by a form of *I. dohrni* Krüger, of Sumatra. Other species in all probability await discovery.

3. *IDIONYX DOHRNI* Krüger, subsp. *BORNEENSIS* nov.

2 ♂♂. Matang, 1905-1907.

Length of hind wing.....	27.5 mm.
" abdomen	25 "
" anal appendages ...	3 "

Fore wing: antenodals 13, postnodals 6, supratriangulars 1, cross-nerves in median space 1.

Hind wing: antenodals 8, postnodals 9, one supratriangular and two cross-nerves in basal space.

Head: under lip brownish-yellow, upper lip yellow with black margin thickest in the middle line, rest of the front of head black with green and violet metallic shades. Occiput black.

Prothorax black above, dark brownish yellow at the sides.

Thorax metallic green above, with three yellow marks on either side. The first is continued up from the coxae of the second pair of legs, lying immediately in front of the humeral suture, ending halfway up the suture. The second begins at the coxae of the hindermost legs and runs up between the wings as a narrow band. The third is a rounded mark lying below the base of the hinder wing.

The abdomen is thin and cylindrical, slightly widened at segments 7-9, almost entirely black; the four anterior segments of a shiny texture, the rest dull. Under surface of 2 and 3 yellow.

Wings smoky, with faint yellow tinge at base; membranule small, grey.

Legs: coxae and base of femurs of first two pairs yellow-brown. Lower third of first pair of tibias, and nearly the whole of second and third pairs, red-brown. The rest very dark brown or black.

Anal appendages a little longer than the last two segments of the abdomen. Upper pair black, lower appendage very dark brown, black at the tip. Seen in profile the upper pair are cylindrical, slightly bowed upwards at their middle, tapering very gradually to the extremity, which ends in a downwardly directed point. The lower appendage slightly overlaps them, and is curved upwards towards its extremity, which carries a minute backwardly directed point.

Seen from above, the upper pair are thick for the first two-fifths of their length, then rather thinner, approximated a little at their middle, then diverging slightly, lastly turning inward again towards their extremities, which have a rounded outline and carry a fine tuft of hairs on their outer sides.

The lower appendage for the first two-fifths of its length is

rather ovoid in shape; at its middle it carries on either side a blunt tooth or spur; the last two-fifths of its course it has nearly parallel sides fringed regularly with fine hairs and its apex blunt in outline.

The 10th abdominal segment carries on its dorsal surface a small, laterally compressed truncate projection.

On the underside of segment 7, at the junction of its middle and distal thirds, is a fine bunch of yellow-brown hairs projecting downwards. This character is perhaps specific, but may occur in the males of other species; I have not seen it noted, and have not been able to examine other specimens*.

I. dohrni borneensis differs from the typical *I. dohrni* from Sumatra chiefly as follows:—

<i>I. dohrni</i> Krüger.	<i>I. dohrni borneensis</i> .
i. All the coxae yellow.	First two pairs of coxae yellow.
ii. Lower anal appendage not overlapping upper pair.	Lower anal appendage slightly overlapping upper pair.
iii. Yellow markings on abdomen more extensive.	

Group iii. MACROMINA.

Genus MACROMIA.

According to Martin, the following species have been recorded from Borneo:—

- Macromia cincta* Ramb.
- " *borneensis* Krüger.
- " *gerstaeckeri* Krüger.
- " *cingulata* Ramb.
- " *westwoodi* Sélys.

I give a brief description of a very large female specimen, collected by Mr. Moulton, which must probably be referred to an unnamed species.

4. MACROMIA sp.

A single ♀ taken in October 1911 at Sadong.

Length of hind wing	58·5 mm.
" abdomen	65 ,,
" pterostigma	3 ,,

The specimen is unfortunately badly damaged. It is remarkable on account of its great size, and is most probably unnamed. I prefer to leave it so for the present, in the hope that more material may be forthcoming shortly.

Fore wing: antenodals 17–19, postnodals 10, supratriangulars 4, median cross-nerves 5.

Hind wing: antenodals 11, postnodals 12, supratriangulars 2, median cross-nerves 4.

* See note at the end of this paper.

Wings of a smoky tint, without any basal colour.

Front of head entirely russet-brown, with metallic-green reflex above; occiput black. Prothorax dark brown. Thorax brown with a faint metallic-green reflex, antealar sinus bright brown. The lateral stripe is of a pale brown colour, and is bordered on either side with more richly metallic colouring.

Abdomen entirely bronze-black, except for a square yellow mark on the base of segment 7 occupying not quite a third of the length of the segment. The first four segments have a strong metallic lustre, the rest are duller.

Legs black, slender.

In the present specimen the span of the fully extended fore wings is 125 mm.

5. MACROMIA CINCTA Ramb.

1 ♂. Baram.

Length of abdomen 49 mm., of hind wing 45 mm.

This specimen agrees exactly with de Sélys's account of *M. cincta*, save that segments 6 and 7 of the abdomen are entirely black.

[*Note*.—The large female *Macromia* described above has certainly a very close resemblance to *M. westwoodi*, especially in the colouring and in the absence of a basal mark to the wings. De Sélys described *M. westwoodi* ♀ as having "deux large bandes antéhumérales fauves," a description which would scarcely apply to the specimen I have described. It is further very considerably larger, but the range of size in species of this genus is not well known so far as Oriental species go, so that whilst I incline to believe that Mr. Moulton's specimen represents an undescribed species, I feel bound to await further material before describing it.]

M. gerstaeckeri is readily distinguished from other Bornean species by its relatively small size (span about 70 mm. in the male, 80 mm. in the female), by the possession of a narrow yellow antemedial line, incomplete above, and by the position of the external tooth on the upper anal appendages of the male, nearly at the extremities of the appendages instead of being at their middles, as in the other Bornean species so far as is known. Further, it has a yellow band across the nasus. I confess that the position of *M. borneensis* Krüger seems to me a little doubtful, it certainly comes very near *M. cincta*. It is impossible, however, to study these species satisfactorily without the advantages of having a good series before one. *M. cingulata* Ramb., with much yellow on the face and abdomen, is very distinct.

Genus EPOPHTHALMIA.

6. EPOPHTHALMIA AUSTRALIS Hagen.

I have examined a young male of this species, collected by

Mr. Moulton. The species has been recently discussed by Dr. Ris.

7. EPOPHTHALMIA VITTIGERA Ramb.

ZYGOPTERA.

AGRIONINAE.

Genus AMPHICNEMIS Sélys.

Certainly one of the most characteristic genera of the Malay province. It has been recorded only from Borneo, Sumatra, and the Philippine Islands. It will ultimately, no doubt, be found to occur in the Malay Peninsula. In its recorded area it is probably represented by very many species.

The genus is notable for several reasons. One of these is the remarkable sculpturing of the hinder lobe of the prothorax found in several species, either in both sexes or in the males alone.

A second, perhaps more remarkable character, is, that whereas males of most of the species at any rate present a very uniform system of colouring of the body, the females, on the other hand, are often more brilliantly coloured than the males, and show, so far as I can judge, a far greater diversity between the species in this respect.

The extreme delicacy of these creatures, and the somewhat bizarre form of the anal appendages of the males, together with the curious prothoracic armature (closely paralleled in the case of *Disparoneura* and some other genera), suggest that the genus is highly specialised and "gerontic": to be compared, perhaps, with *Opisthostoma* amongst the land molluscs, and *Calamaria* amongst the snakes of the same province. No observations are available on the habits or life-history of the species.

The material I have studied consists of six male specimens belonging to five species, and of five females belonging to four species; representing in all, probably, six distinct species.

1. AMPHICNEMIS WALLACEI Sélys*. (Pl. IV. fig. 7.)

1 ♂. Baram, 15.10.10 (adult).

Length of abdomen..... 32·5 mm. (without appendages).
" hind wing ... 18·5 "

This specimen agrees closely with de Sélys's description of the type, whilst the anal appendages bear an exact resemblance to those figured by Dr. Ris for a specimen from Sintang.

[The female is said by Dr. Ris† to have the whole thorax, the femora, and tibiae blood-red, the tarsi yellow, and the spines of the legs dark. The prothorax is without the median spine which occurs in the male sex.]

* De Sélys, Synops. des *Platycnemis*, no. 2, Bull. Acad. Belg. 1863.

† Ris, Ann. Soc. Ent. Belg. lv. 1911, pp. 236-237, figs. 4 & 5.

2. AMPHICNEMIS LOUISÆ, sp. n. (Pl. IV. figs. 5, 5 a.)

1 ♂. Baram, Sarawak, 1910 (adult).

1 ♀. Limbang River, 3.4.10 (adult).

♂. Very similar in appearance to *A. wallacei*.

Lower lip dark brown, upper lip dark bronze-green; the rest of the dorsal surface of the head black, with metallic reflex.

Prothorax: above and at the sides bronze-black; below whitish. A small spine rises from the middle of the posterior margin, it is hooked vertically upwards, and is about one-half the size of that found in *A. wallacei*. Seen from above, the lateral angles of the posterior margin are produced as a very small pair of outwardly directed spurs.

Thorax: above dark metallic green, below brownish white.

Abdomen: segments 1 and 2 metallic green above, brownish white below. The succeeding segments are of a dull brown colour, becoming progressively darker, their under surfaces paler.

Pterostigmata black, with a very fine grey margin, which is much narrower than in *A. wallacei*. 13 antenodals in the fore wing.

Legs white (first two pairs lost), with articulation between femur and tibia black, a fine black line running along the whole posterior surface of the femur. Tarsus missing.

Anal appendages whitish, lower pair about four-fifths the length of upper pair. The upper pair are curved a little downward, their extremities flattened laterally and folded in on themselves. Each has at its middle a rounded projection directed inwards. Lower pair much as in *A. wallacei*, but ending in an upturned point.

♀. Agrees with the male in the characters of the prothoracic posterior margin. The whole of the prothorax and thorax is of a rich orange-yellow colour, the alar sinuses have dark metallic-green spots, and the prothoracic spine is tipped with the same colour. The legs are blood-red, with black articulations and black spines, the tarsi yellow. Abdomen similar in colour to that of the male, but duller.

The vivid colouring of the female gives it a very striking appearance.

3. AMPHICNEMIS MADELENÆ, sp. n. (Pl. IV. figs. 6, 6 a.)

2 ♂♂. Kuching, 11.11.09.

♂ adult. Length of abdomen 32 mm.
" hind wing 18 "

Lower lip yellowish white, upper lip pale yellow, with its base brown, and a median and two lateral minute black spots. Epistome black; upper surface of head dark green; basal joints of antennæ pale brown.

Prothorax: upper surface and sides metallic green, under surface pale yellow with slight orange tinge. Posterior margin with a long, median cylindrical horn, nearly vertical, dark at its base, pale towards the extremity, proportionately much longer than in

A. wallacei. Seen from above the lateral angles of the posterior margin are acute, but scarcely produced to form spurs.

Thorax: above metallic green, on the sides a pale pearly green, yellowish white below.

Abdomen with segments 1 and 2 metallic green above, yellowish white below; the rest brownish black above, paler below, progressively darker backwards; 9 and 10 uniform very dark brown, almost black. Wings with the *pterostigmata of the hinder pair bright orange*, darker in the centre. Those of front wings dark grey with paler margin. Legs entirely yellowish brown, darker at the articulation, spines dark brown.

Anal appendages white in the younger male, tipped with purple-brown in the more mature specimen.

Upper pair slender, cylindrical, slightly bowed downwards, dilated at the extremities, the dilated part being folded over on itself so that there is a ventral groove or channel. There is also a small blunt internal projection at about the middle of the length of each. Lower pair rather stout, antler-like, a little compressed laterally, each with a strong tine directed inwards and upwards at its middle.

Female unknown.

4. AMPHICNEMIS REMIGER Laidlaw*.

1 ♂. Batu Lawi.

[I have described this species elsewhere. Here I give its characters very briefly. No prothoracic spine. A small lateral spine to posterior prothoracic margin. Pterostigmata of all four wings grey. Legs primrose-yellow with a black ring at each articulation. Anal appendages white, upper pair slender with a small dorsal tooth at their middles, extremities flattened to form an oval paddle-shaped expansion. Lower pair shorter, slender, ending in a fine upturned point. Female unknown.]

5. AMPHICNEMIS MARTINI Ris †.

1 ♂. Limbang. 1 ♀. Matang Rd., near Kuching.

The male has been compared with the type by Dr. Ris, who has kindly informed me that he can find nothing to distinguish it therefrom, save that whilst in the type the pterostigmata of the hinder wings are of a yellowish white, in Mr. Moulton's specimen they are bright orange.

The posterior prothoracic margin is without projections. The legs are pale orange-yellow with yellow spines and black tibio-femoral articulations. The anal appendages are figured by Dr. Ris. They are missing, together with the last three abdominal segments, in this specimen.

The single female included here has also been examined by

* Journ. Str. Br. Roy. Asiat. Soc. 1912 (paper not yet published).

† Ris, loc. cit. pp. 237-238, fig. 6.

Dr. Ris, who believes it to be rightly referred to the present species. He observes that the shape of the posterior prothoracic margin is similar to that of *A. wallacei* ♀, but not identical with it. It is gently convex, with marked lateral angles. The colouring is very different from that of the female *A. wallacei*, and approximates to the colouring of the male. The dorsal surface of the prothorax and thorax is bronze-green, their sides a pale pearly green; under surfaces and legs whitish yellow. There is a complete longitudinal black line on the posterior surfaces of the femurs, black spines, and black articulations. The abdomen has segments 1 and 2 bronze-green above, dull yellow below; the remaining segments are of a dull brown colour, paler below, progressively darker from before backwards.

Length of abdomen 32 mm., of hind wing 20 mm.

The head is too much crushed and shrivelled to permit of any description.

6. AMPHICNEMIS sp.

2 ♀ ♀. Baram, 14.10.10.

Length of abdomen 33·5 mm., of hind wing 20 mm.

Upper surface of head entirely dark metallic green. Prothorax red-orange, rather paler below; its posterior dorsal margin gently convex, produced on either side into a fine backwardly directed short spur. Thorax with a rather narrow bright metallic-green band, succeeded laterally by blood-red colouring, which fades into a dull orange-red on the under surface; alar sinuses metallic green.

Abdomen: segments 1 and 2 lustrous brown above, each with a terminal metallic-green ring. The rest of the abdomen brown above, pale whitish brown below, darker posteriorly.

Pterostigmata grey-brown with pale margin.

Legs red, tarsi whitish yellow, articular markings black, spines dark brown.

The colouring of these specimens resembles very closely that of *Teinobasis rajah* recently described by me. There can be no doubt that these specimens should be referred to *Amphicnemis* and not to *Teinobasis*. They have been examined by Dr. Ris, who has favoured me with the subjoined remarks on them:—

“ I am at a loss to give good characters for separating *Teinobasis* and *Amphicnemis*—this although I believe that the two are quite distinct genera, as proven by the widely different type of ♂ appendages. There is certainly a difference in stature also, *Amphicnemis* being decidedly the more delicate, with especially a very narrow and feebly built thorax. But a good character that would do for both sexes and for all the species is still to be sought for, my material is so very insufficient for such an investigation. I believe the great similarity in colour of the two forms in question (*Amphicnemis* sp. ♀ and *T. rajah*) is merely a case of convergence.”

The following brief characterisation of the known species of *Amphicnemis* may be useful:—

A median posterior prothoracic spine present in both sexes.

Spine similar in both sexes; upper surface of thorax of female without metallic colouring. *A. louisea*, sp. n. Borneo.

Spine in female longer than in the male; thorax above with golden bronze marking. *A. gracilis** Krüger. Sumatra.

Prothoracic spine in male only.

Large species (abdomen ♂ 45 mm.); thorax of female with metallic band above, and with marked lateral projections to posterior margin of prothorax. *A. lestooides* Brauer†. Mindanao.

Smaller species (abdomen ♂ 36 mm.); thorax of female entirely blood-red. *A. wallacei* Sélys. Borneo.

No prothoracic spine in males.

Pterostigmata of hind wings orange-yellow in male; colouring of female similar to that of male, also without prothoracic spine; small species (abdomen ♀ 32 mm.). *A. martini* Ris. Borneo.

Pterostigmata of hind wings of male grey or black; small species (♂ abdomen 34 mm.), ♀ unknown. *A. remiger* Laidlaw. Borneo.

Pterostigmata of hind wings of male grey; large species (♂ abdomen 41 mm.); female coloured very much like the male. No prothoracic projections. *A. ecornuta* Sélys‡. Sumatra.

Lastly, *A. furcata* Brauer § from Luzon has no median spine but a lateral pair in the male, whilst the pterostigmata are all black; *A. madelenea*, sp. n., from Borneo, has the pterostigmata of the hind wings orange-yellow, and a long cylindrical median prothoracic spine in the male; in both species the female is unknown.

Legion PROTONEURA.

Genus DISPARONEURA Sélys, Ris emend. ||

Lower lip with short rounded lobes; pterostigma rhomboidal or lozenge-shaped; lower section of triangle present as a vestige or absent. No supplementary basal postcostal nerve. Basal postcostal lying between the level of the antenodal nerves.

The genus so defined ranges from the Cape of Good Hope through Tropical Africa to India, Ceylon, Burmah, and the Malay Peninsula and Great Malay Islands. It appears to show advancing specialisation from west to east both as regards colour and venation characters, reaching its maximum in Borneo, east of which island its occurrence is doubtful. [Two species described by de Sélys as belonging to the genus *Alloneura*, from the Philippine Islands, were subsequently referred to *Disparoneura* by him, but as in his description no special reference is made to the position of the basal postcostal nerve, which is the character used here to distinguish the two genera, and as I have not been able to examine examples of these two species, their exact position I

* Krüger, Stett. Ent. Zeit. 1898, pp. 121-123.

† Brauer, Verh. zool.-botan. Gesell. Wien, 1868.

‡ De Sélys, Ann. del Mus. Civ. di Genova (2) vii. 1889. Krüger, loc. cit.

§ Brauer, loc. cit.

|| See note at the end of this paper.

treat as doubtful. They are *Disparoneura?* *integra* Sélys, and *Disparoneura?* *obsoleta* Sélys.]

Further east the genus is replaced by the closely allied *Caco-neura* (*Alloneura*), which in regard to venation is still further specialised.

Like many other genera which are richly developed in the Malayan region, it appears to be but poorly represented in Java. The Malayan species appear to fall into three groups characterised by the coloration of the males.

One of these groups, possibly the most primitive, has the males black with yellow markings on the head and thorax. A second is that in which the males show blue markings on a black ground.

In the third group the males are black, with carmine, brick-red, and orange-coloured markings.

The females of all these groups appear to be very similar as regards colouring; they are black, with dull yellow or orange markings. They are, however, remarkable in the possession of various curious developments of the margin of the prothorax.

The grouping of the species according to the colouring of the male is suggested by Förster*, who regards certain forms with black and red males as races or subspecies of *D. verticalis*. I have here extended the limits of his "*verticalis* section" to include all the black and red Malayan species with no lower sector of the quadrilateral, or with only a trace of it. I think it unnecessary to treat these species as mere subspecies of *verticalis*; I believe them to be well characterised and readily recognisable species.

I propose to group them as follows:—

- A. Head of the male with a red band passing from eye to eye, across the ocelli.
 - 1. ♂. Anterior surface of thorax orange-red, upper lip black, anal appendages red-brown.
 - ♀. Head black with orange band passing from eye to eye; prothorax black with lateral orange lines, the posterior margin deeply lobed (échantré) at its middle. Thorax black, with three yellow bands on either side. *D. dorsalis* Sélys. Borneo.
- 2. ♂. Upper lip red; broad red bands on front of thorax.
 - ♀. Head black with yellow band from eye to eye; prothorax black with livid-red lateral lines, its posterior margin carries on either side a strongly curved point. Thorax black, with three yellow or livid-brown lines on either side. *D. verticalis* Sélys. Borneo.
- 3. ♂. Small red antehumeral lines on the anterior surface of the thorax; prothorax with a large red spot on either side.
 - ♀. Head with complete yellow band from eye to eye; prothorax with large red spot on either side. Posterior margin? Small red humeral band on prothorax, and two yellow lateral ones on either side. *D. delia* Karsch. Sumatra. Java (Förster).

(None of the males of *D. dorsalis* that I have examined has any trace of a lower sector of the quadrilateral. In *D. verticalis* this is at least usually present.)

* Förster, *Fascic. Malay., Zool. pt. iv. Odonata, pt. ii.* p. 14.

B. Upper surface of the head of the male entirely black.

- [1. ♂. Upper lip pale yellow, prothorax entirely black; no antehumeral band on thorax, two yellow lateral stripes on either side. Segments 3-7 of the abdomen carmine-red above, anal appendages yellow above.

♀. Unknown.

D. hyperythra Sélys. Borneo.]

2. ♂. Genae of a bright yellow colour, head otherwise entirely black. Prothorax with lateral carmine spots. Thorax with a fairly broad antehumeral carmine band, a brick-red succeeded by an orange line on either side of the thorax. Abdomen with carmine-red on segments 1 and 2 above.

♀. Unknown.

D. hosei, sp. n. Borneo.

3. ♂. Head entirely black, prothorax with small lateral carmine spots. A fine carmine antehumeral stripe on thorax, with lateral brick-red and orange lines; abdomen entirely black.

♀. Head with yellow band from eye to eye. Prothorax with a small pair of lateral bosses on the median lobe, the posterior margin produced backwards into a flat rounded median collar.

D. humeralis Sélys. Malacca;

- 3a. ♂. Antehumeral line absent, prothorax all black. Java.
D. humeralis, var. *nigra* Förster. Pahang.

4. ♂. Head entirely black, prothorax entirely carmine above. Abdomen with segments 1, 2, 3 carmine above.

- (?) ♀. Head with very narrow incomplete line passing from eye to eye; lateral ends of posterior margin of prothorax produced to form two large forwardly directed horns (cf. *D. verticalis*).

D. peramœna, sp. n. Borneo.

The presence of a lower sector of the quadrilateral appears to be fairly constant in *D. humeralis*, and perhaps generally absent in the other species.

Of the group which includes males with blue and black markings, Borneo possesses the following species:—

D. interrupta Sélys,

D. collaris Sélys,

D. lansbergi Sélys (?);

whilst *D. moultoni* Laidlaw and *D. gracillima* Sélys perhaps represent a third group, with yellow markings on a black ground. *D. moultoni* shows, I believe, some relationship to *D. hyperythra*, and may be a melanotic species allied to it, and not primitive.

Lastly, *D. aurantiaca* Sélys is a handsome Bornean species with the anterior surface of the thorax bright orange, and plentiful orange markings on the abdomen in the male, which is very distinct in its venation and colouring from other members of the genus found in the island. The posterior margin of the prothorax of the female carries subtriangular, strongly recurved, plate-like extensions.

Description of new species.

DISPARONEURA PERAMŒNA, sp. n. (Pl. IV. figs. 8, 8a.)

2 ♂ ♂, 2 ♀ ♀. Lawas and Limbang, Aug., Sept., 1909.
Length of abdomen: ♂ 29.5 mm.

„ hind wing: ♂ 16 mm.

No trace of lower sector of quadrilateral. Upper sector of quadrilateral of fore wing extending to the first cross-nerve after the quadrilateral in all the specimens. In the hind wing variable, ranging from the nodal cross-vein to that immediately beyond it.

Postnodals of fore wing 14–15.

♂. Head entirely black, including the lower surface.

Prothorax : above of a rich carmine, anterior and posterior lobes delimited by a fine transverse black line. Sides and under surface black.

Thorax black ; in front a pair of carmine bands, slightly crescentic, extending for about two-thirds of its length from its anterior margin, succeeded at the top of the thorax by a minute carmine spot. Antealar sinuses of the same colour. Anterior lateral thoracic band of a brick-red colour, the posterior, on the metepimeron, yellow.

Legs black, coxae and a ring round the base of the femora brown.

Abdomen black, segments 1 and 2 carmine above ; 3 has at its base above a very long narrow carmine triangle with its apex directed backwards, extending for about one-fourth the length of the segment.

Anal appendages black, dark brown at their bases.

The upper pair seen from the side have their posterior margin rather crescentic, with an inwardly directed spur on the lower side. Lower pair with the posterior margin \mathbf{Z} -shaped, the terminal hook rather more slender than in most species of the genus.

♀. Head black, upper lip yellow ; a very fine yellow mark runs inward from each eye to the ocelli, but does not form a complete band.

Prothorax black ; median lobe with a pair of round lateral yellow spots, anterior lobe with a very small lateral yellow mark. The median lobe is almost hemispherical. The posterior margin is produced on either side so as to form a curious horn-like projection directed upwards and then forwards.

The thorax is black. There is a fine yellow antehumeral stripe incomplete above, extending about one-third the length of the upper surface. There is a well-marked yellow lateral band, and behind this the yellowish grey of the under surface shows at the side of the metepimeron.

Legs brownish black, the anterior surfaces of the femora and tibiae yellow.

Abdomen dull brown, paler beneath, with a small subterminal pale ring on segments 3–6 ; the last three segments almost entirely black.

The male is characterised especially by the colour of the head and prothorax ; the female appears to approach that of *D. verticalis*, but differs in details of coloration. I believe I have correctly referred the females described above to this species, but as was the case with that described by de Sélys for *D. verticalis*, the evidence is not conclusive.

DISPARONEURA HOSEI, sp. n.

1 ♂. Baram, Borneo.

Length of abdomen	32 mm.
" hind wing	18 "

Fourteen postnodal costals on the fore wing.

Head entirely black above and below, save for a fine yellow mark on the genæ. Prothorax black above, with a small carmine spot on each side of the three lobes on either side; yellow markings underneath about the articulations of the limbs.

Thorax black, with a rather broad complete pair of antehumeral bands of a rich carmine colour, a median lateral pair with an orange tone, and a sharply defined posterior pair yellow in colour. Ventrally the thorax is black, save for yellow points at the articulation of the limbs, as in the prothorax.

Abdomen black; segment 1 has a small transverse, terminal, carmine band dorsally, 2 is entirely carmine above, 3 has a fine carmine line above running nearly the whole length of the segment, tapering to a very fine point posteriorly.

Legs black, the femurs have a yellow ring at their bases, best marked on the posterior pair.

The abdominal appendages are black, the upper pair seen in profile are about equal to the lower pair; these latter in profile appear blunt, but seen from above they end each in an incurved hook, as do those of allied species.

This species is very near *D. humeralis* from Malacca. It is characterised by the yellow genæ, the broad carmine antehumeral bands, and the red markings on the first three abdominal segments.

The single specimen was received some years ago from Mr. Hose along with other material from Baram.

Genus PROTOSTICTA Sélys.

PROTOSTICTA VERSICOLOR, sp. n.

1 ♀. Lawas, 15.9.09 (27·6).

Length of abdomen 27 mm., of hind wing 19 mm.

Fifteen antenodal nerves in fore wing. Basal postcostal nerve lies at a level widely proximal to that of the first antenodal costal nerve. A second postcostal nerve, probably representing a trace of the lower sector of the quadrilateral, lies at a level just proximal to the second antenodal costal. Pterostigma trapezoid, covering more than one cell. Upper sector of triangle reaching some distance beyond the nodus in fore wings.

Head bronze-black, upper lip greyish white, lower lip brown.

Prothorax and thorax chocolate-coloured above and on the sides, with a metallic lustre. Under surfaces pitch-black.

The prothorax is provided with a remarkable spine resembling very closely that found in certain species of the genus *Amphi-cnemis*. It rises from the middle of the posterior margin and is

about 1 mm. in length. It projects upwards with a slight forward curving.

The abdomen is very slender. Segment 9 longer than 8. Segments 1-8 of a dull brown colour growing darker from before backwards, each of the segments 2-8 with a pale narrow ring at either end, 9-10 of a chocolate bronze-colour. The legs are dull yellow, with dark articulations and cilia.

I cannot at the moment recall any other Malayan Agrionid which has the under surface of the thorax actually darker than the upper side. This peculiar colouring of the thorax, together with the pale yellow legs, gives this insect a very striking appearance. It is further distinguished from other species of the genus, which is new to Borneo, by the prothoracic spine.

Genus PLATYSTICTA Sélys.

PLATYSTICTA RUFOSTIGMA Sélys. (Pl. IV. fig. 9.)

1 ♂. Lawas, August 1909. (No. 34.)

Length of abdomen	34 mm.
", hind wing	22 "

The specimen agrees in every particular, excepting size, with the type from Labuan. The latter is distinctly smaller, whilst Mr. Moulton's specimen approaches *P. quadrata* in size. The anal appendages further resemble those of the type of *P. rufostigma*, and differ completely from that figured by me for *P. quadrata**.

I am thus able to record 13 species referable to the legion 'Protoneura,' arranged in three genera, for the island of Borneo.

EXPLANATION OF PLATE IV.

- Fig. 1. Ventral view of terminal segments of abdomen of *Metaphya micans* Laidlaw. ♀.
- 2. Lateral view of second abdominal segment of *Metaphya micans* Laidlaw. ♂.
- 3. Lateral view of anal appendages of the same.
- 4. Terminal segments of *Idionyx dohrni* Krüger ♀, for comparison with fig. 1.
- † 5. Profile view of prothorax of *Amphicnemis louisae*, sp. n. ♂.
- 5a. " " anal appendages of the same.
- 6. " " prothorax of *A. madeleinae*, sp. n. ♂.
- 6a. Lateral view of anal appendages of the same.
- 7. Profile view of prothorax of *A. wallacei* Sélys.
- 8. " " *Disparoneura peramena*, sp. n. ♀ (anterior end to the right).
- 8a. Similar view of male anal appendages of the same species.
- 9. Lateral view of anal appendages of *Platysticta rufostigma* Sélys. ♂.

NOTE.—Since the above notes were written I have received from Dr. Ris copies of two accounts recently published by him dealing with Dragonflies from the Orient. The first of these (*Supplementa Entomologica*, Deutsch. Ent. Mus. No. 1, Aug. 1912,

* Laidlaw & Förster, in *Fascic. Malay., Zool. pt. iv. Odonata*, pt. ii. p. 9, fig. 1.

† The profile figures are drawn on one plane, and, in consequence, the lateral angles are not shown.

pp. 44–84, Taf. iii.—v.), discusses new Dragonflies from Formosa, South China, Tonkin and the Philippine Islands. Amongst others, two species of the genus *Idionyx* are described as new. In the case of one of these, *I. claudia* Ris, from Tsa-Yin-San, the male carries on the under side of segment 7 of the abdomen a brush of hairs exactly similar to that which I have described as occurring in *I. dohrni borneensis*. Dr. Ris figures this feature in his paper (*loc. cit.* p. 83, fig. 18). The second paper (*Tijdschrift voor Entomologie*, Deel Iv. 1912, pp. 158–182, pls. 6, 7, 8) contains an account of Odonata from Java and Krakatau. The characters of the genus *Disparoneura* and *Cacconeura* are discussed, and a specimen of *D. humeralis* from Mula (Java) is recorded.

6. On the Structure of Bone in Fishes: a Contribution to Palaeohistology. By EDWIN S. GOODRICH, M.A., F.R.S., F.Z.S., Fellow of Merton College, Oxford.

[Received November 7, 1912: Read November 26, 1912.]

(Text-figures 13–16.)

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In a paper on the Scales of Fishes, published in the ‘Proceedings’ of this Society five years ago (1), I showed that the so-called “Ganoid” scales are of two kinds, differing fundamentally in minute structure and mode of growth. Scales of the first kind, to which the name Cosmoid was given, are typically covered with an outer layer of cosmine, and grow by the addition of new cosmine at the edge and new layers of bony tissue on the inner surface. The second kind, the true Ganoid scale, grows by the addition of new complete concentric layers, formed of cell-less ganoine on the outer surface and bony tissue on the inner surface. Cosmoid scales are found in the Dipnoi and Osteolepidoti (extinct Crossopterygii), and in these only. True Ganoid scales occur only in the Actinopterygii and Polypterini (which probably belong to the Actinopterygii, 2). Moreover, it was further shown that the Ganoid scales can also be distinguished into two varieties—the Palaeoniscoid and the Lepidosteoid. The former is characterised by the presence of a middle cosmine-like layer, and occurs only in the Chondrostei (Palaeoniscidae and their allies) and in the Polypterini; while the latter variety—the Lepidosteoid scale—is found in the Orders Amioidei (Protospondyli, + Pholidophoridae, and Oligoleuridae) and Lepidosteoi (Lepidosteidae and Aspidorhynchidae). The lepidosteoid scale is easily distinguished by the absence of the middle cosmine-like layer and by the presence of a system of delicate tubules running through and at right angles to the bony layers. The tubules have been described by Reissner (5), Hertwig (3), and Nickerson (4).

in the scales of *Lepidosteus*, and by myself in those of various extinct Amioids and Lepidosteoids (1, 2). They branch, as a rule, only at their inner end, and pass outwards to the surface. In the living tissue they are occupied by the long protoplasmic processes of large cells on the surface of the scale. Probably, these remarkable cells are merely modified bone-cells, which, instead of becoming buried in the ostein matrix, remain outside it while retaining their connection, by means of the long process, with the place they originally held. This interpretation is illustrated in text-fig. 13.

Text-fig. 13.

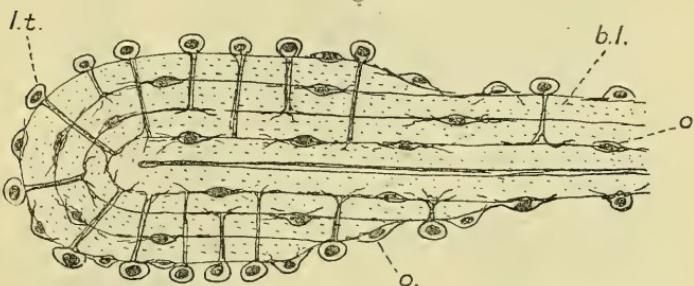


Diagram illustrating the structure and growth of lepidosteoid bone.

b.l., bony lamella ; *l.t.*, lepidosteoid cell ; *o.*, osteoblast or bone-cell.

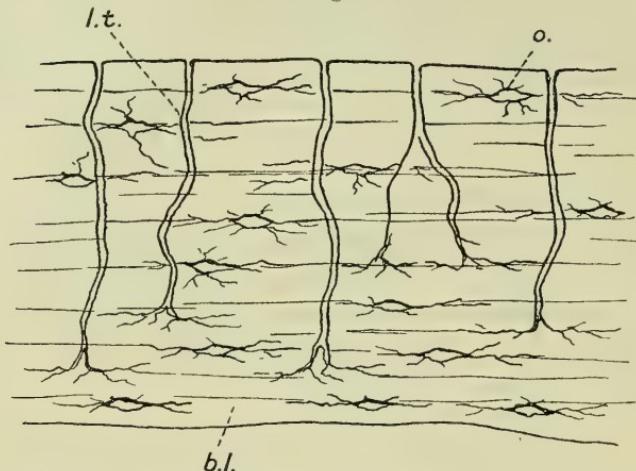
It follows that the Actinopterygii can be classified into two large groups according to the structure of their scales: the first is distinguished by the possession of palaeoniscoid scales, and contains the Chondrostei (with which the Polypterini should probably be placed, 2); the second group contains the Amioidei (Protospondyli, Pholidophoridae, and Oligolepididae) and the Lepidosteodei (*Aethospondyli*).

Now it might be expected that this striking difference in the histological structure of the true ganoid scales would also be found in the cranial plates and other dermal bones of these fishes, and this is indeed the case. The dermal bones resemble the scales not only in appearance, but also in microscopic structure. Often the resemblance is so close that they cannot be distinguished; but the dermal bones may, of course, lose the covering of ganoine, as sometimes happens with the scales themselves in the more modified forms. Thus, whereas lepidosteoid tubules are never found in any part of the skeleton of the Polypterini or Chondrostei, they occur in the dermal bones of all the recent and extinct Amioidei and Lepidosteodei I have been able to examine, with a single possible exception (*Oligoleurus*) to be discussed later*.

* I am much indebted to Dr. A. Smith Woodward for the supply of most of the material on which these researches were carried out, and to Miss R. Harrison for the preparation of a large number of microscopic slides of the bone of various fishes.

Not the dermal bones alone, however, show the lepidosteoid structure, but the *whole endoskeleton* as well. The skull-bones, the ribs, even the vertebral centra, are all provided with the characteristic tubules traversing the bony lamellæ, just as in the

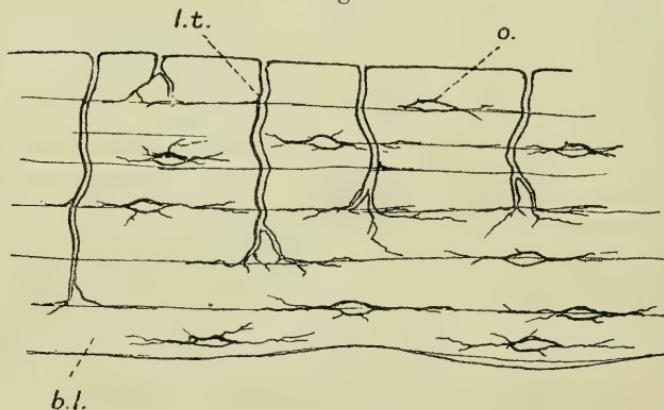
Text-fig. 14.



Enlarged view of a section of the endoskeletal fin-ray of *Lepidosteus osseus*.

Lettering as in text-fig. 13.

Text-fig. 15.



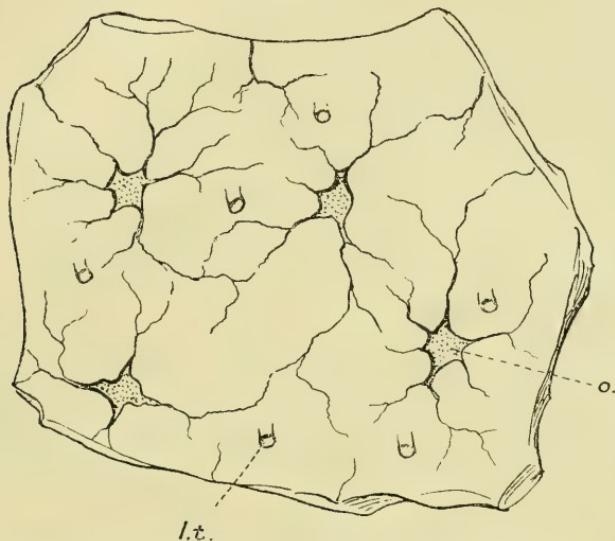
Enlarged view of a section through the neural spine of *Amia calva*.

Lettering as in text-fig. 13.

scales (text-figs. 14-16). This remarkable and interesting fact has not, so far as I am aware, hitherto been observed. It follows that, from the examination of the minutest fragment of the

skeleton of a living or extinct species of fish, we can decide whether or not it belongs to the Amioidei and Lepidosteoidae, or to some other group. The histological structure of the bone may therefore be of the greatest practical value for the identification of fragmentary specimens*. It also may prove of great importance in the interpretation of phylogeny.

Text-fig. 16.



Enlarged view of a fragment of the vertebral centrum of *Ophiopsis*.

Lettering as in text-fig. 13.

We cannot as yet determine for certain which type of bone is the more primitive; but I am strongly inclined to believe that the lepidosteoid type is the more specialised form, some of the osteoblasts having become modified to form tubules. This conclusion is supported by the evidence of palaeontology, since no Amioid or Lepidosteoid is known below the Permian, while Chondrostean occur in the Devonian strata. In the absence of decisive evidence we may suppose that the lepidosteoid structure first appeared in the scales, then spread to the dermal bones, and, finally, reached the deepest parts of the endoskeleton—this, of course, is mere conjecture. At all events, since we find ordinary bone in all the Osteolepidoti, Cœlacanthini, Polypterini, and

* The following is a list of the Actinopterygii examined:—Lepidosteoidae: *Lepidosteus*, *Aspidorhynchus*. Amioidæ: *Eugnathidæ*—*Eugnathus*, *Caturus*, *Heterolepidotus*. *Pachycormidæ*—*Pachycormus*. *Semionotidæ*—*Lepidotus*, *Dapedius*. *Macrosemiidæ*—*Macrosemius*, *Ophiopsis*. *Pycnodontidæ*—*Mesturus*, *Gyrodus*. Amiidae—*Amia*. Pholidophoridae—*Pholidophorus*. Oligolepididae—*Spathiurus*, *Oligoleurus*, *Enoscopus*. Also *Leptolepis*, *Thrissops*, and a large number of Teleosts.

Chondrostei, it would seem that the Amioidei and Lepidosteoidae have been derived from a common ancestral form which developed the lepidosteoid scale and bone, diverging in this and other respects from the remainder of the Teleostomi.

It becomes now a matter of great interest to ascertain from which group the Teleostei may have been derived. On general anatomical grounds they would certainly be associated with the Amioidei (2). But so far I have been unable to discover the lepidosteoid structure either in the scale or in the skeleton of any living or extinct species of Teleost, even after the examination of representatives of a very large number of families. In the lower Teleostei (including the Leptolepidæ) the bone is of the ordinary structure, similar to that of *Osteolepis* or *Palaeoniscus*; but, as is well known, in the higher forms it becomes generally very much modified, chiefly owing to the loss of the bone-cells. Only in the Fistulariidæ does the structure of the bone recall that of the Amioid. Even here, however, the resemblance is not close, and I have not been able to convince myself that the fine canals described by Stewart (6) are really homologous with lepidosteoid tubules.

In connection with the phylogeny of the Teleostei it is interesting to note that *Oligopleurus vectensis* A. S. W. has no lepidosteoid tubules in its endoskeleton. *Oligopleurus esocinus* Th. I have not had an opportunity of examining; but *Spathiurus* and *Zuoscopus*, the only other genera belonging to the family, have the typical lepidosteoid structure in the scales, dermal bones and endoskeleton. Associated with a skeleton of *Oligopleurus vectensis* in the British Museum is a plate, either a scale or a dermal scale-like bone, of typical lepidosteoid structure; it cannot, however, be made out for certain whether this bone belongs to the skeleton or not. *O. vectensis* certainly differs in bone-structure from other Amioids, and probably should be placed not with the Oligopleuridæ, but with the Teleostei*.

We may suppose that the common ancestor of all the Holostei (Amioidei, Lepidosteoidæ, and Teleostei) was some primitive Actinopterygian with lepidosteoid scales, but in which the lepidosteoid structure had not yet penetrated to the endoskeleton. If this supposition is correct, "*Oligopleurus*" *vectensis* might perhaps be a representative of such an unspecialised group. Placed by some authors among the Amioids, and by A. Smith Woodward among the primitive Teleosts (7), it certainly appears to be a somewhat intermediate form.

As a provisional hypothesis, the view may be adopted that the Amioids and Lepidosteoids on the one hand, and the Teleosts on the other, diverged from a primitive group possessing lepidosteoid scales and ordinary bone; and that in the former the lepidosteoid structure spread inwards over the whole endoskeleton. The extreme modification of the scales in the Teleost series would

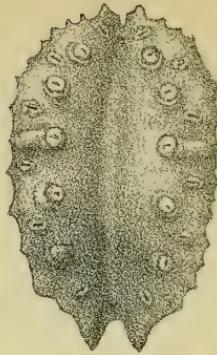
* Mr. Regan informs me that *O. vectensis* is without fulera, and resembles the Leptolepidæ in the structure of the tail, and should be included in that family.



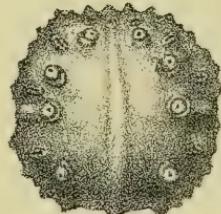
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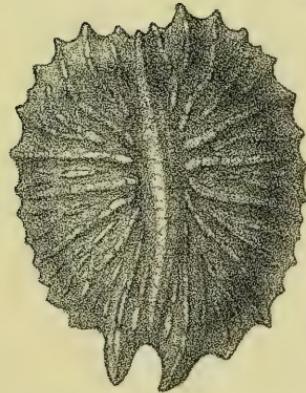
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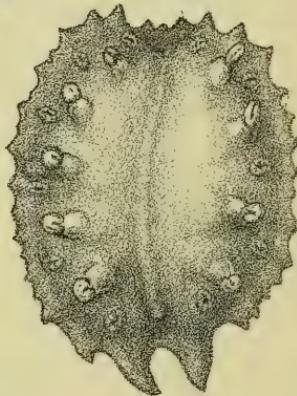
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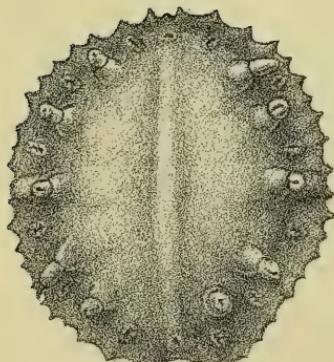
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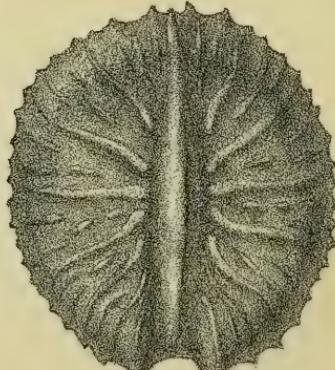
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2^b



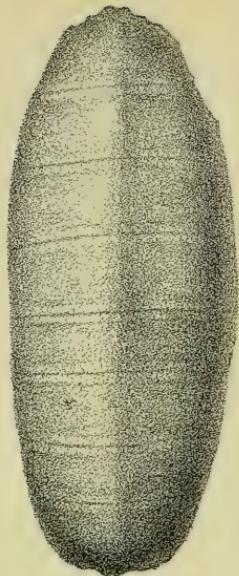
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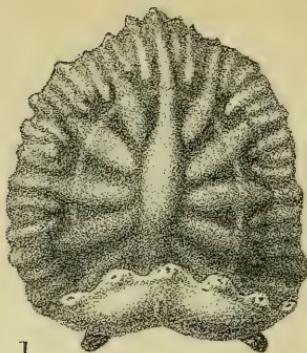
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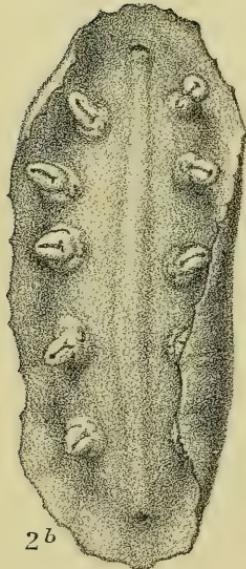
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2^a



1



2^b



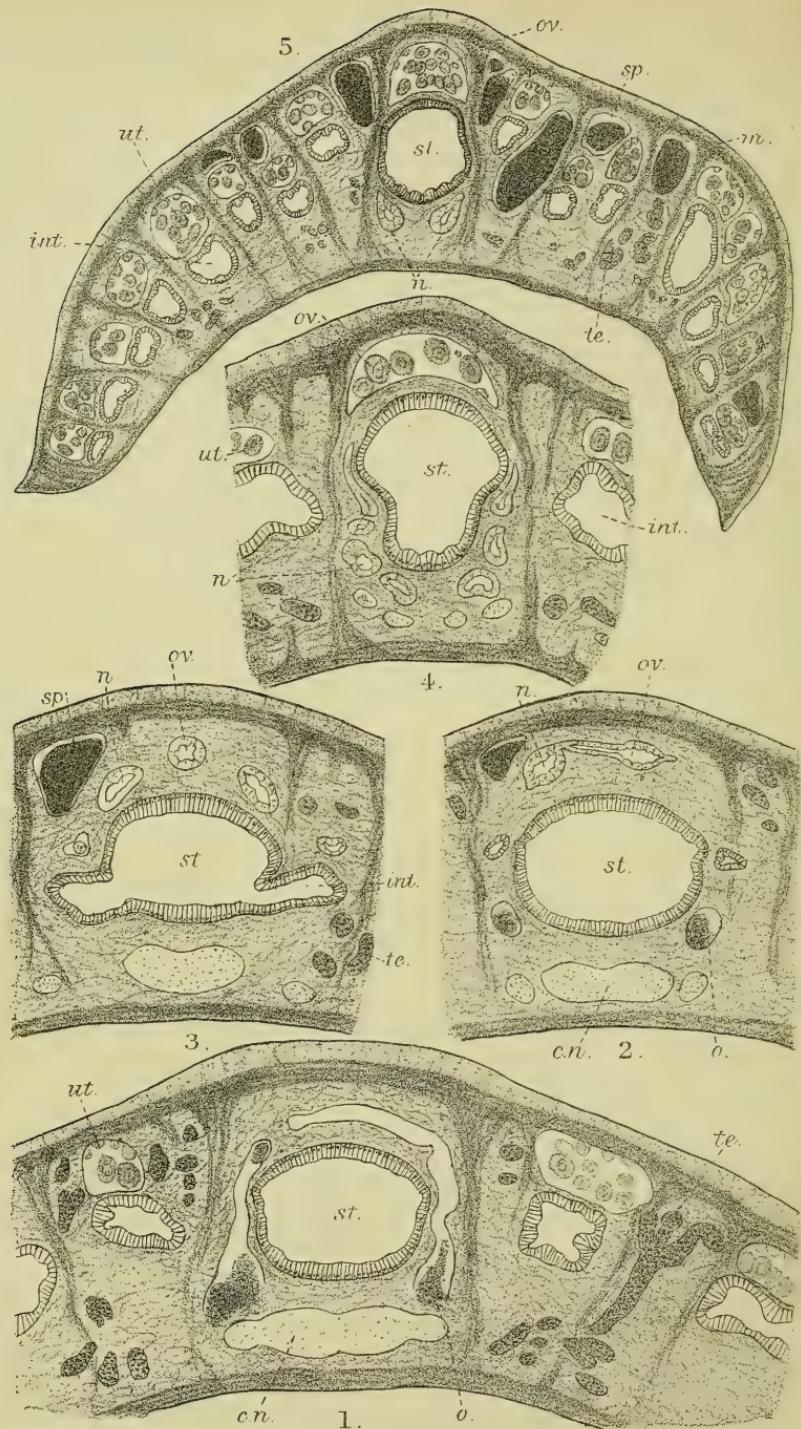
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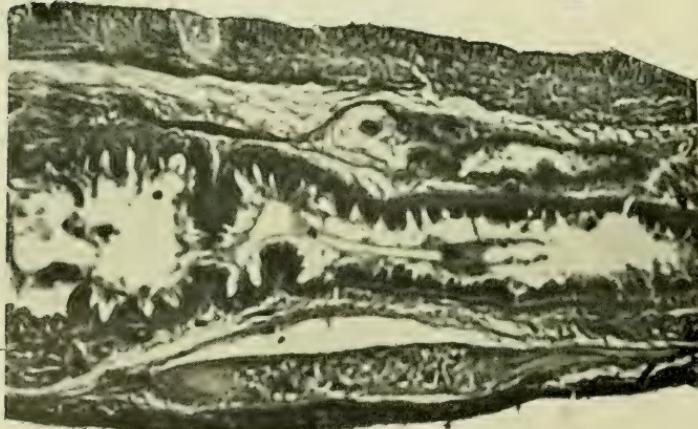
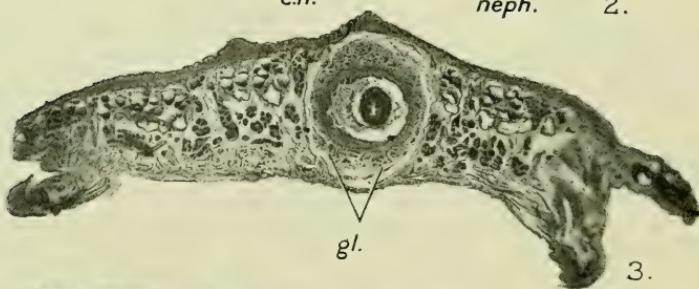
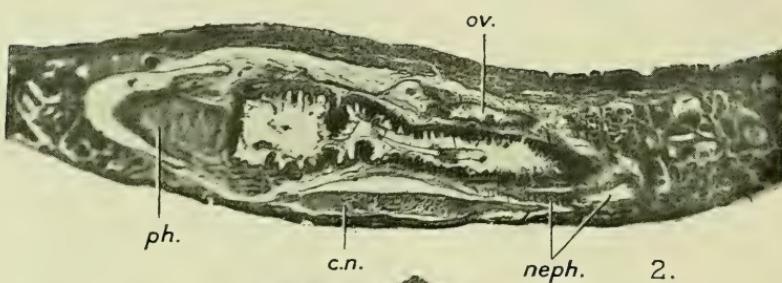
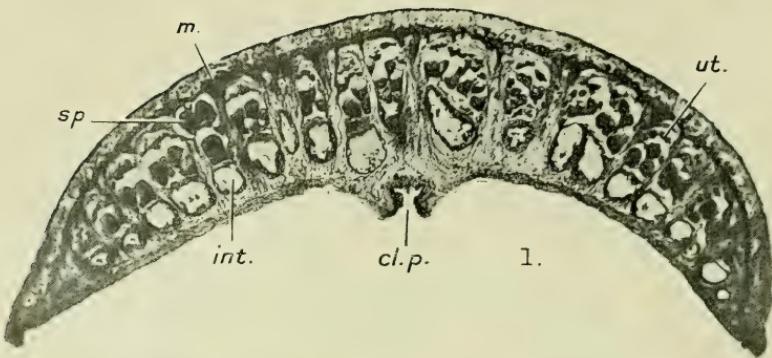
Percy Highley del et lith

C. Hodges & Son imp.

1. MYZOSTOMA RUBROFASCIATUM *v. Graff*

2-3. M. CROSSLANDI, *Sp.n.*





1. *MYZOSTOMA CROSSLANDI*. 2-4. *M. COSTATUM*.

sufficiently account for the loss of the tubules in these fishes. Obviously much remains to be done before the full significance of the structure of bone can be elucidated, and this paper has been written with the object of drawing attention to the interest and importance of this new line of research.

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7. Report on the Myzostomida collected by Mr. Cyril Crossland in the Red Sea in 1905. By CHARLES L. BOULENGER, M.A., D.Sc., F.Z.S., Lecturer on Zoology in the University of Birmingham.

[Received November 12, 1912: Read November 26, 1912.]

(Plates V.–VIII. and Text-figures 17–23.)

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The Myzostomida described in this report were collected by Mr. Cyril Crossland on the Sudanese coast of the Red Sea in

1905 and were sent, together with the other Annelida, to Mr. F. Potts, of Trinity Hall, Cambridge, who submitted them to me for examination.

Mr. Crossland's collection is of considerable interest, since very little is known of the Red Sea Myzostomida, and the only two species recorded from that locality were described from very scanty material.

The material as I received it from Mr. Potts consisted of six tubes containing about 170 specimens. Of these six belong to a species hitherto unknown and which I take great pleasure in dedicating to Mr. Crossland; two I have referred to v. Graff's *Myzostoma rubrofasciatum*, described from a single specimen in 1884; whilst the remainder belong to a species which I take to be the old-established form *Myzostoma costatum*, one of the first three species of the group described by Leuckart so long ago as 1830.

The importance of a collection of this kind, however, is not to be judged by the number of species represented in it. About 100 species of *Myzostoma* are on record and of these by far the greater number have been described from external characters only, ill-preserved or limited material having made a complete examination impossible. Mr. Crossland's specimens were in an excellent state of preservation and I have been able to give a fairly complete account of the anatomy of two of the forms mentioned above; moreover, the very large series of specimens of *M. costatum* reveals a range of variation remarkable even for this group of animals, and affords an opportunity of judging the merits of various characters for systematic purposes.

In my descriptions of the species I have endeavoured to give as complete an account as possible of the general morphology of the various organs, especially of those which might be of taxonomic interest. I have, however, refrained from attempting any histological decriptions, as I felt it useless to do so without material specially preserved for such a purpose. Throughout this paper I have retained as far as possible the nomenclature of parts used by v. Graff (7-9)* and Nansen (15), and have not followed the example set by some of the more recent workers on the Myzostomida.

I desire to take this opportunity of thanking Mr. Potts for entrusting me with this valuable material; Prof. F. Jeffrey Bell very kindly allowed me to examine some of the types of the 'Challenger' collection of Myzostomida preserved in the British Museum (Natural History), and I am also indebted to Mr. H. C. Chadwick, of the Port Erin Biological Station, for information concerning the Red Sea Echinoderms from which Mr. Crossland's specimens were obtained †.

* The figures in brackets refer to the List of References on p. 107.

† I also wish to express my indebtedness to Mr. Cox, of the Zoological Department of this University, for the excellent photographs reproduced on Pl. VIII.

MYZOSTOMA COSTATUM F. S. Leuckart. (Pl. V. & Pl. VIII. figs. 2-4.)

M. costatum Leuckart (10), p. 612; (11), p. 8, pls. i.-ii.

„ v. Graff (7), p. 11, pl. i. figs. 13-14; (8), p. 32.

Myzostoma costatum was one of the first three species of the genus described by F. S. Leuckart in 1830 (10), his account being based on specimens obtained in the Red Sea from *Comatula multiradiata* Lam.

A more complete description of these specimens was published by the same author in 1842 (11), together with the following brief diagnosis of the species:—

“Char. specif. : Corpore depresso, ovali, margine crenulato, dorso costato; acetabulis suctoriis et hamuliferis separatis, acetabulis utrinque quatuor et hamulis in utroque latere quinque. Hab. in mari rubro, Comatulæ multiradiatae parasitus.”

The species was rediscovered by Semper, who obtained two specimens from Bohol, in the Philippines, and these were described by v. Graff in his well-known monograph published in 1877 (7). The two individuals, which measured $3\frac{1}{2}$ and $2\frac{1}{2}$ mm. in length respectively, agreed closely with those described by Leuckart. The dorsal surface presented the characteristic rib-like elevations which gave the name to the species, and, moreover, the animals possessed another feature noticed by Leuckart, namely a small triangular incision at the anterior end of the body, at the apex of which the mouth is situated. v. Graff's diagnosis of *M. costatum* was as follows:—“Corpus ovale depresso, incisura antica trianguli, griseo-aut nigro-brunneum, supra costatum. Costa una longitudinalis mediana qua communicantes 10-14 costæ transversales ad marginem productæ. Margine orientes inter has costæ breviores secundariæ et tertiaræ illam longitudinalem non attingentes marginemque crenulantes. Parapodia crassitudine uncinorumque forma *M. glabrum*, longitudine *M. cirriferum* aequantia. Acetabula elliptica. Os ad basin incisuræ triangularis, ventrale, papilla cloacalis ventralis. Longit. ad $3\frac{1}{2}$ mm. In mari rubro Comatulæ multiradiatae Lam., in mari prope Bohol Actinometra solaris Lam. incola.”

A few years later v. Graff obtained another specimen, collected by Haeckel at Tur, near Sinai, and described it in the ‘Challenger’ Expedition Report (8). This specimen was of a yellowish-brown colour and measured nearly 2 mm. in length. The breadth was rather greater than the length, and the anterior notch, as well as the “ribs,” were not so distinct as in the specimens from Bohol; the marginal notches were, however, more marked.

As mentioned above, of the large number of Myzostomids collected by Mr. Crossland more than 160 belong to a species which, although differing somewhat from previous descriptions, I have decided to refer to Leuckart's *M. costatum*. The series of specimens is a most interesting one, containing individuals of all sizes between 0.5 and 4 mm. in length and presenting a wide range of variation.

Mr. Crossland's specimens were obtained from two localities:

(a) at a depth of 10 fathoms in Suez Bay on *Antedon serripinna* Carpenter, (b) at Ul Shubuk (9 fathoms) from *Antedon savignyi* Müller, and from Ophiurids* which lived with their arms twisted round those of the Crinoid. This is not the first time an Ophiurid has been described as the host of Myzostomids: H. L. Clark in 1902 (4) called attention to the occurrence of a species† on *Asteroceras pergamenta* Lyman, and remarked that the position of the worms upon the concave underside of the arms made it clear that they had not become accidentally attached to the Ophiurids since the latter were dredged‡. With regard to Mr. Crossland's specimens, I think there can be little doubt but that the actively moving Myzostomids had migrated from the arms of the *Antedon* on to those of the commensal Ophiurids; it is important to note that *Antedon savignyi* is most probably the *Comatula multiradiata* Lam., from which Leuckart obtained his type-specimens of *Myzostoma costatum*.

A typical adult individual (*cf.* Pl. V. figs. 1-5) has a flat body, approximately oval in shape; the breadth is usually greatest anteriorly, the posterior region narrowing slightly behind the last pair of parapodia. There is no distinct transparent border, the intestinal and uterine branches extending to the body-margin.

On the dorsal surface a median longitudinal elevation is well marked, running along the whole length of the animal; it is broadest near the middle of its course. From this median elevation arise 6-8 (usually 7) pairs of primary costæ which radiate outwards and terminate on the body-margin. The second to fifth pairs are frequently the most developed, the first and last two or three being less distinct and often incomplete. Between the primary costæ are secondary and tertiary ones, as described by v. Graff, their number and arrangement varying greatly. In some individuals the costæ are broken up so as to form rows of flat tubercles (Pl. V. fig. 2). The body is thickest in the region of the median longitudinal elevation and gradually thins down towards the margins.

According to Mr. Crossland's notes, the colour of the living worms is "greenish white, with white dorsal ridge and two longitudinal grey lines on either side of it." The colour of the preserved specimens varies considerably; a few individuals kept in a separate tube are of a greenish-grey colour, but the majority are of a dark sepia-brown; this coloration is probably artificial and due to some dissolved pigment in the alcohol with which the worms were preserved.

The margin of the body is indented so as to form a series of broad, approximately triangular processes, of which in a well-

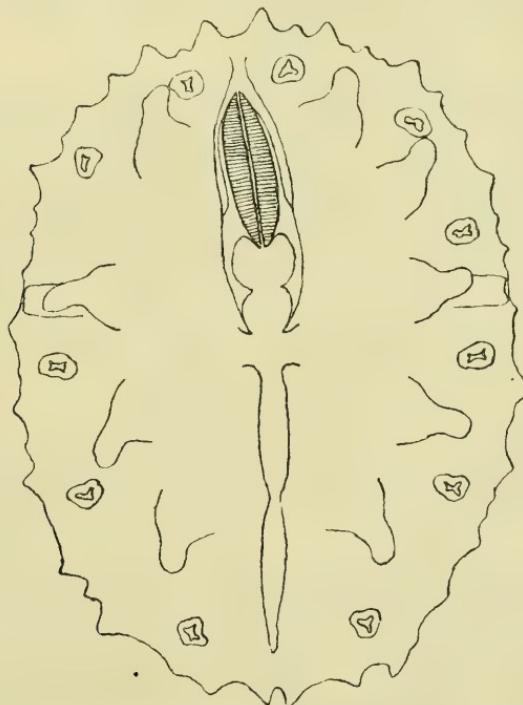
* Not yet identified.

† This species has since (1906) been described by McClendon (13) under the name of *Myzostoma japonicum*.

‡ Another species of *Myzostoma* has since been recorded from *Ophiacantha vivipara* (Koehler, Bull. Sc. France et Belg. vol. xli. p. 279), *cf.* also Fedotov (6).

developed specimen there are 40–50, roughly corresponding to the number of costæ which terminate on them. These processes are, of course, cirri; they are better developed and more regular in size in some individuals than in others, but in most cases they present the appearance of typical cirri only on the anterior margin in front of the mouth, where the body is thinner and more delicate than posteriorly. The last pair of cirri is in most cases considerably enlarged, forming a pair of caudal appendages into which

Text-fig. 17.



Myzostoma costatum.—Sketch of a mounted specimen 2·25 mm. in length. Caudal appendages are not present and the individual is abnormal in possessing only four parapodia and five suckers on one side of the body.

branches of the alimentary canal and uterus extend; in some individuals these appendages reach a length equal to nearly one-sixth of the length of the body. The penultimate and antepenultimate pairs of processes are frequently enlarged also, but never quite to the same degree.* The shape of the posterior extremity

* This characteristic enlargement of the posterior cirri was not described by previous investigators of this species; v. Graff's figure (7, pl. i. fig. 14 a), however, shows a distinct triangular incision at the posterior end of the body, indicating that something of the kind occurred in the specimens examined by him.

of the body is subject to great variation, and it seems that the development of caudal appendages bears no relation to the size of the individual, these organs being absent in some specimens of considerable size (*cf.* text-fig. 17), and, *per contra*, being well developed in individuals under a millimetre in length.

The presence of caudal processes, as well as the number of these organs, are characters which have been used to a considerable extent for taxonomic purposes; the above description, however, shows how unsafe it is to fix the limits of species by them.

The ventral surface is quite smooth; the five pairs of parapodia have the usual radial arrangement, and their insertions are approximately equidistant between the centre of the body and the periphery.

The structure of the parapodia is as described by v. Graff (7); they recall those of *M. cirriferum*, although differing in being rather more muscular. When fully extended they project as far as the body-margin or even slightly beyond it, their extremities being sometimes visible in a dorsal view of the animal.

The parapodia seem capable of movement in every direction, and in his field-notes on this species Mr. Crossland remarks that the little animals "move their leg-like parapodia very actively, like the legs of an insect, and can crawl actively about the arms of the Ophiuroids and on a needle, but not on glass."

The hooks are powerfully built, and their terminations strongly bent, more so than in *M. cirriferum*, being in this respect intermediate between that species and *M. glabrum*.

Lateral to the third parapodium on either side is a large male genital papilla; its insertion is close to the base of the parapodium, and when completely protruded it can extend beyond the margin of the body.

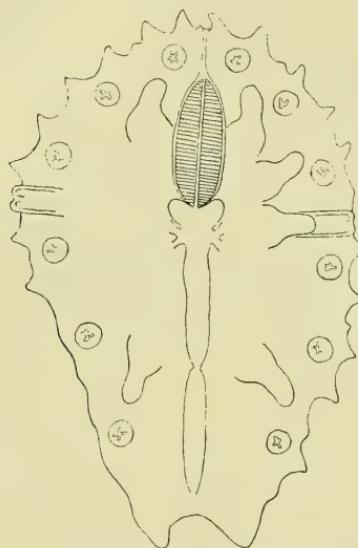
Both mouth and cloaca are ventrally situated close to the extremities of the body. Except in one individual the anterior body-margin in front of the mouth is complete and without a triangular incision. In the specimen figured on Pl. V. fig. 4, such an incision is present, and in this respect it resembles those described by v. Graff and Leuckart. I am, however, inclined to consider this a post-mortem phenomenon due to the abrasion of the delicate area which I mentioned above as occurring just in front of the mouth.

In a ventral view of *M. costatum* the "suckers" are quite conspicuous, and of these there are usually six pairs, all equally developed and situated close to the periphery of the body. Four pairs are in the usual position, that is to say in the interspaces between the five pairs of parapodia, these are the second to fifth pairs; the first is situated in front of the first pair of parapodia, close to the anterior margin, whilst the last or sixth pair of suckers lies approximately halfway between the last pair of parapodia and the posterior median termination of the body.

The suckers have much the same structure as those described by Wheeler (17) in *M. glabrum*, and when retracted appear as

spherical or oval bodies with walls so thick that the cavity is almost obliterated or reduced to an irregular ramifying slit between the folds of the wall.

Text-fig. 18.



Myzostoma costatum.—Sketch of an abnormal specimen 1·25 mm. in length. Only two parapodia are present on one side of the body, and four on the other; the number of suckers is normal.

The number of suckers in Mr. Crossland's specimens is quite constant, and, apart from some otherwise abnormal individuals, there were only a few in which all twelve could not be made out by means of the microscope. This is by far the most serious discrepancy between my account of *M. costatum* and that of previous authors, and for some time I considered establishing a new species to receive Mr. Crossland's specimens. It seems probable, however, that the extra pairs of suckers have been overlooked; even when well developed these organs are difficult to make out on unmounted specimens of Myzostomids, a fact which the majority of workers on this group have commented on from time to time. Leuckart's description of *M. costatum* was naturally incomplete, and the few specimens seen by v. Graff seem to have been in a rather poor state of preservation and much contracted; no mounts were made, and under the circumstances the extra suckers, if present, might easily have remained unnoticed.

The presence of six pairs of suckers in a species of *Myzostoma* appears of considerable interest, since it necessitates some modification in the definition of the group, as well as of the generally

accepted views on the morphology of the Myzostomida. W. M. Wheeler, in his important paper on the sexual phases of these animals (17), discusses the structure and homologies of the suckers at some length. These organs (which he prefers to call segmental sacs) he considers to be metamerie, lying laterally or dorsally to their respective parapodia, like the "Seitenorgane" of the Capitellidae, and for various reasons he believes them to be homologues of these lateral line organs or segmental sacs. In the course of his discussion of this subject we find the following passage :—“The fact that in *Myzostoma* there are five pairs of parapodia but only four pairs of segmental sacs, naturally leads to the question as to what has become of the missing pair of sacs. The answer to this question I believe we need not go far to seek; *the third pair of the original five pairs of sacs has been converted into the so-called penes.* These are more or less prominent papillæ, lateral to and near the bases of the third pair of parapodia. Each papilla is perforated by a ductus ejaculatorius, which widens proximally into a vesicula seminalis. The latter receives the mature spermatozoa from the vasa deferentia, and these in turn from the ramifying testicular follicles. Bizarre as the development of a male reproductive organ from a lateral line organ may appear at first sight, I am nevertheless unable to see any great difficulty in such a change of function. It is, in fact, easy to see how the bottom of an eversible sac might acquire an opening into the body-cavity under the pressure of a great accumulation of spermatozoa; the sac would then become reduced to a mere conduit.”

A few years later von Stummer-Traunfels (16) investigated the anatomy of the curious endoparasitic form *M. asteriae* Marenz., and showed that this species possesses a median sucker behind the last pair of parapodia; whilst describing Wheeler's view of the homology of the penes as somewhat far-fetched, he considers this extra sucker to represent the missing fifth pair, and his researches on the innervation of this organ show that it must have been formed by the fusion of two originally separate suckers.

Since the publication of my preliminary note (3) on the suckers of *M. costatum*, Fedotov (6) has described a remarkable type of Myzostomid, an endoparasite of the brittle-star *Gorgonocephalus eucnemis* Müller et Troschel; in this form, named *Protomyzostomum polynephris*, five pairs of suckers are present, and these are not situated between the pairs of parapodia on the ventral side, but opposite to them and in a dorsal position. It is to be hoped that further investigation of the anatomy of this new genus may throw some light on the relations between suckers and parapodia in the Myzostomids; meanwhile, the occurrence of six pairs of suckers in *M. costatum* merely complicates the problem. Granting the metamerie nature of these organs, we must now consider that we are dealing with six segments instead of five, and it seems necessary to account for a missing sixth pair of parapodia *.

* Cf. also remarks under “Nervous System” on p. 95.

The above description of *M. costatum* refers especially to full-grown specimens measuring between $1\frac{1}{2}$ and 4 mm. in length. Young specimens under $1\frac{1}{2}$ mm. present a somewhat different appearance; the body is thinner, and the costæ on the dorsal surface are less conspicuous than in the adult; though in some cases very faint they are never absent. The marginal region is more delicate and transparent than in the larger specimens, this being due to the absence of ova in the peripheral branches of the uterus; 12–20 pairs of well-defined cirri are present, and between them can be seen smaller processes which are about to give rise to more of these organs. The last pairs of cirri show the same tendency towards enlargement as in the adults. The suckers are not very prominent, but the male papillæ are fully developed and are extremely conspicuous.

Before concluding my account of the external features of this species, I wish to call attention to the fact that quite a considerable number of specimens in Mr. Crossland's collection present abnormalities chiefly regarding the number of parapodia. In these specimens one or more parapodia are missing from one or both sides of the animal, and, although in some cases this may be due to injury and incomplete regeneration of parts of the body, in others the malformations must have been congenital. I have figured some of these abnormal specimens; the sketch (text-fig. 18) on p. 91, shows an extreme case, that of an individual measuring 1·25 mm. in length, which possesses four parapodia on one side of the body and only two on the other; the rest of the animal seems normally developed, and the full number of suckers is present. In some cases reduction in the number of parapodia is accompanied by a similar reduction in the number of the suckers (*cf.* text-fig. 17, p. 89).

Alimentary Canal.

As mentioned above, the mouth is situated on the ventral side close to the anterior extremity of the body; through it can be protruded a large and muscular pharynx provided at its distal end with small papillæ, as described by v. Graff; these are very inconspicuous in all the specimens before me, and, so far as I can ascertain, number four only.

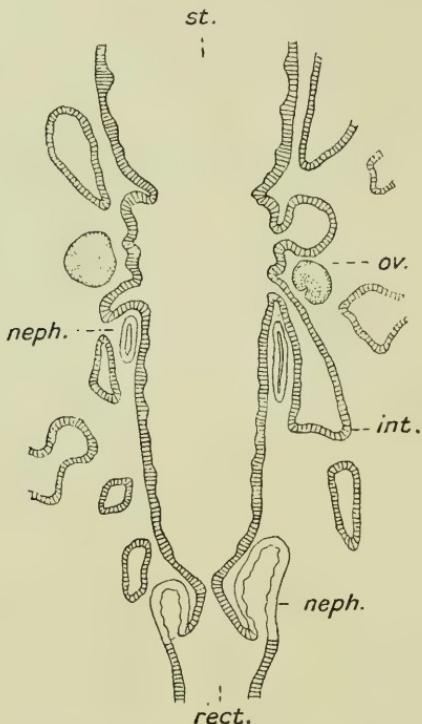
The stomach is elongated, extending back as far as the level of the last pair of parapodial bases, and constricted laterally at the points where the intestinal branches arise, almost opposite the male genital papillæ.

There are only two intestinal trunks on each side arising close together from the stomach; these divide into from 7–9 primary branches, which in their turn radiate outwards and give rise to numerous diverticula, which end blindly on the body-margin.

The rectum is separated from the stomach by a distinct valve-like constriction, and takes the form of a straight tube running back from the level of the last pair of parapodia to the cloaca, where it is joined by the oviduct.

Surrounding the base of the pharynx and the extreme anterior end of the stomach is a thick ring of cells (*cf.* Pl. VIII. fig. 3) resembling the "multipolar" cells described by Nansen ((15), p. 71) as occurring close to the circum-oesophageal nerve-ring in several species, and which he considered to be ganglionic cells forming a kind of sympathetic system. Similar cells were found by v. Stummer (16) in *M. asteriae*, but this author showed that

Text-fig. 19.



Myzostoma costatum.—Longitudinal horizontal section through part of the body to show the position of the ovaries and nephridia.

st. Stomach. *rect.* Rectum. *int.* Intestinal trunk. *ov.* Ovary. *neph.* Nephridium.

their minute structure differed considerably from that of ganglionic cells, and that the presence of secretion granules and capillary ducts indicated that they were of a glandular nature.

The cells surrounding the anterior end of the stomach of *M. costatum* very closely resemble those described by v. Stummer (*cf.* (16) p. 551, pl. xxxvii. figs. 5 & 6); in this species, however, they are more numerous and not so scattered; moreover, the capillary ducts are all directed towards the gastric epithelium.

I think there can be little doubt but that v. Stummer was right in considering these cells to be unicellular glands. In *M. costatum* these glands may have a digestive function; they certainly form the only glandular tissue in connection with the alimentary canal in this species.

Nervous System.

The best and most complete account of the Myzostomid nervous system is that published by Nansen in 1885 (15); it was based on investigations made on several species, especially *M. giganteum* Nansen, *M. graffi* Nansen, and *M. cirriferum* Leuckart. In these forms, which can be regarded as quite typical, the nervous system consists of a feebly-developed circumpharyngeal ring communicating with a ventrally-situated unsegmented nerve-mass, from which eleven pairs of nerves arise. Of these nerves five on each side are large and supply the five parapodia, as well as the parts of the body-margin on both sides of them, whilst the other six are more slender and alternate with the larger nerves supplying the parts of the body between the parapodia.

Text-fig. 20.

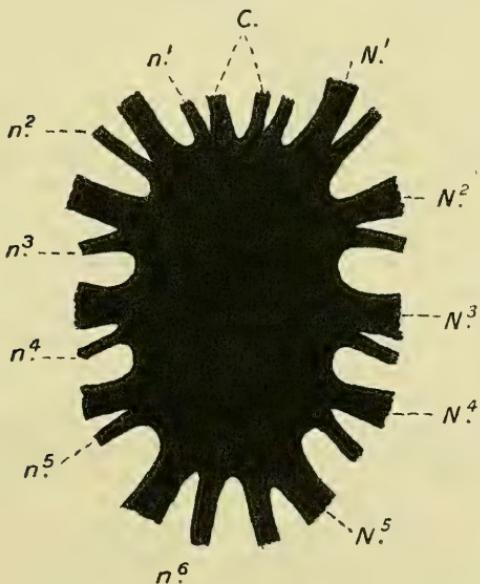


Diagram to show the origin of the paired nerves from the ventral nerve-mass in *Myzostoma costatum*.

N^1-N^5 . The five pairs of large nerves. n^1-n^6 . The six pairs of smaller nerves.
C. Circumpharyngeal commissures.

Nansen did not state the nerve-supply of the "suckers," but v. Stummer (16) believes these organs to be innervated by branches

of the small nerves, at least in the species which he examined, *M. asteriae* Marenz.

I spent some time in attempting to reconstruct the nervous system of *M. costatum*, as I hoped that the distribution of the paired nerves might shed some light on the problem of the homologies of the additional suckers in this species; the diagram (text-fig. 20) on p. 95 gives, I think, a tolerably accurate idea of the nerves arising from the ventral nerve-mass.

It will be seen from the diagram that the nervous system of *M. costatum* is remarkably similar to that described by Nansen in other species, and especially to that of *M. cirriferum*; the number of nerves arising from the central mass is normal; there are eleven pairs, of which five are large and branch chiefly to the parapodia. I agree with v. Stummer in believing the suckers to be supplied by branches of the smaller intermediate nerves; the six pairs run almost straight out towards the six pairs of suckers, but I was unable to trace the finer branches actually into these organs.

It will be seen from my diagram that in *M. costatum* the origin of the six pairs of smaller nerves differs somewhat from that in the species described by Nansen; the first on each side seems to originate from the circumpharyngeal commissure, whilst the remaining five are given off posteriorly from the bases of the five larger nerves to the parapodia.

If we take for granted that the suckers in *Myzostoma* are "Seitenorgane" homologous with those of other Annelids and therefore parts of the parapodia—and I think Wheeler and v. Stummer have made out a very strong case for such a homology,—then it becomes obvious from the above account that each sucker belongs to the parapodium anterior to it. In the majority of species the fifth pair of parapodia has lost its "Seitenorgane," these being retained in four species only—*M. asteriae*, *M. costatum*, *M. moebianum**, and *Protomyzostomum polynephris*. In the latter form they have remained in the more normal position, *i. e.*, lateral and dorsal to their respective parapodia. The innervation of the first of the six pairs of suckers in *M. costatum* from the circumpharyngeal commissures suggests that these may belong to a peristomial segment from which, as in other Annelids, the locomotory portions of the parapodia have disappeared.

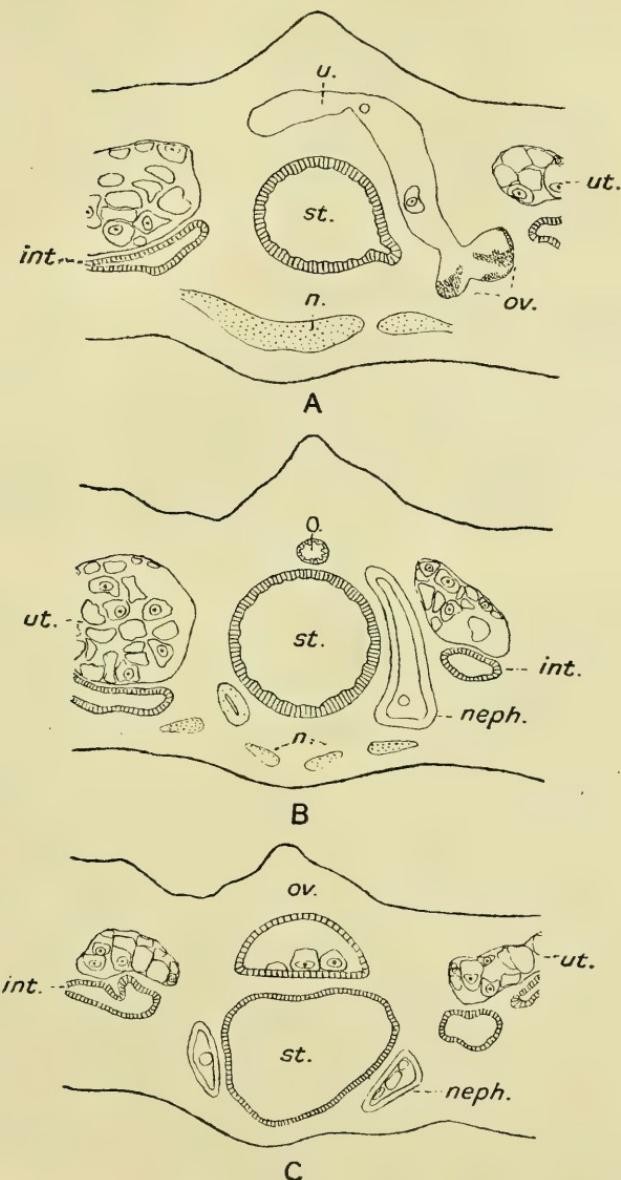
I wish again to emphasize the fact that I have been unable to prove that the suckers really are innervated from the six pairs of finer nerves, and that therefore the above conclusions are highly speculative. I think, however, that they afford a satisfactory explanation of the variation in the number of suckers in this group.

Sexual Organs.

Like nearly all well-investigated species of *Myzostoma*, *M. costatum* is hermaphrodite, and all the larger specimens in

* Cf. Boulenger (3, p. 350).

Text-fig. 21.



Myzostoma costatum.—Three transverse sections through the centre of the body : as in text-fig. 19, only the outlines of the various organs are shown and the testicular follicles are omitted. The sections are slightly oblique, so that right and left halves of the figures show different regions.

st. Stomach. int. Intestinal branch. neph. Nephridium. n. Ventral nervous system. ov. Ovary. o. Anterior narrow end of the oviduct. u. Median division of the uterine coelom. ut. Branch of the uterus.

Mr. Crossland's collection are in what Wheeler (17) terms the androgynous phase, both male and female organs being fully developed and functional *. The smaller specimens, however, exhibit a marked protandric condition; as already mentioned, those under about 1·5 mm. in length possess a well-developed male apparatus of relatively greater size than in the adults. Closer examination of such specimens reveals that whilst ripe spermatozoa are present in abundance, the female organs are but poorly developed, and mature ova absent or rare in the uterus and oviduct.

Male Organs.

The testes, as in other Myzostomids, are much branched; the ramifications of each organ are for the most part restricted to the ventral parenchyma below the alimentary canal, but occasional dorsally directed branches are given off between the intestinal and uterine diverticula. There is a single vas deferens on each side of the body, which widens out distally to form a vesicula seminalis, usually packed full of ripe spermatozoa, at the base of the genital papilla. A short ductus ejaculatorius lined with ectoderm leads through the papilla to the exterior.

Female Organs.

M. costatum possesses a single pair of ovaries situated near the middle of the body, ventro-laterally to the stomach, and occupying the spaces between the four main intestinal trunks (text-figs. 19, 21 A). In structure the ovaries resemble those of *M. glabrum* as described by Wheeler (17), being irregular in shape; as a matter of fact they are to be considered as formed by the proliferation of the peritoneal epithelium at the terminations of ventrally directed diverticula of a small coelomic space, which occupies a transverse position dorsal to the stomach in this region. The uterus, as in other species, consists of a series of ramifying coelomic diverticula lying dorsal to the intestine and corresponding roughly, both in number and arrangement, with the main branches of this organ. The uterine branches, like those of the intestine, radiate outwards from near the centre of the body, and arise from the lateral terminations of the transverse coelomic space mentioned above (text-fig. 22). This space and its ventrally directed diverticula which connect it with the ovaries are lined by a low epithelium of small ciliated cells; in the uterine branches, which in adult specimens are filled with ova in various stages of development, this epithelial lining is absent, being replaced by a "pseudoepithelium" similar to that described by von Stummer-Traunfels in *M. asteriae* (16).

The oviduct is sharply marked off from the uterus; it lies dorsal to the stomach and rectum in the middle line, and has the form of a straight wide tube, narrowing somewhat posteriorly, and

* Cf. also Coventry (5).

much dorsiventrally compressed along its whole length (text-fig. 21 C); the organ is lined throughout by a distinct epithelium

Text-fig. 22.

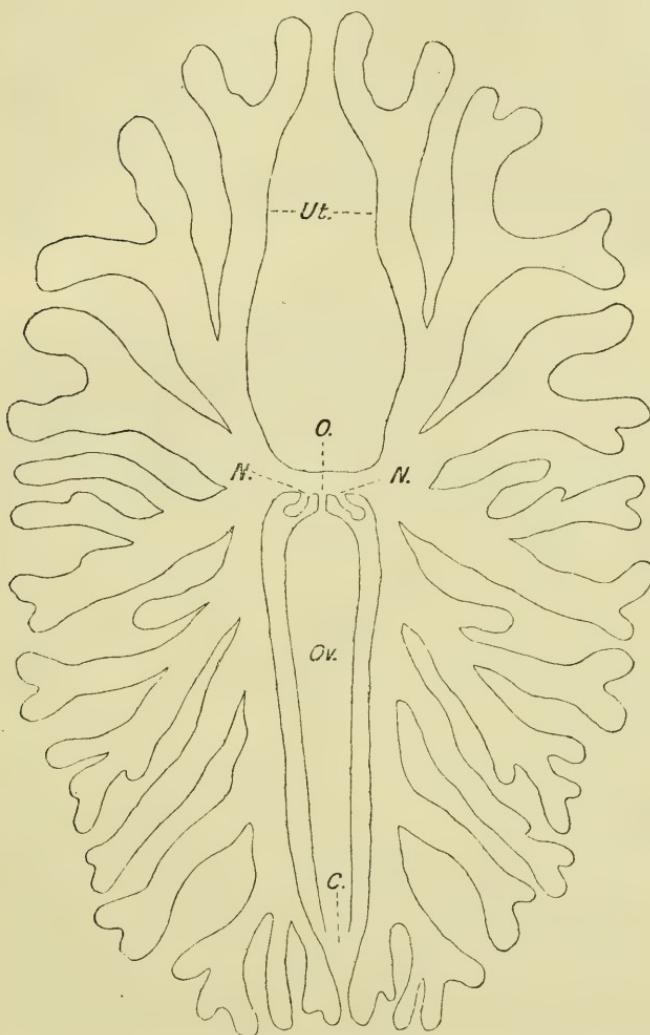


Diagram to show the relations between the uterus, oviduct, and nephridia in *Myzostoma costatum*.

Ut. Uterus. *Ov.* Oviduct. *O.* Opening of oviduct into the uterine cœlom.

N. Internal openings of the nephridia. *C.* Position of the cloaca.

of comparatively large ciliated cells. Anteriorly the oviduct communicates with the central cœlomic space by means of a

short, narrow duct (text-figs. 21 B and 22, and Pl. VIII. figs. 2 and 4), also lined by a ciliated epithelium; the latter, however, consists of very small cells with long cilia, and seems continuous with the epithelium lining the coelom. The diameter of this tube is less than half that of a mature ovum such as one finds in the uterus; it is, however, surrounded by transversely arranged muscle-fibres, which no doubt allow the dilatation of the tube necessary for the passage of such ova into the oviduct.

The above account shows that, at least in *M. costatum*, the oviduct is quite a distinct structure, and I have therefore used for it the name employed by the older investigators of Myzostomid anatomy. I cannot follow Wheeler and v. Stummer-Traunfels, who refer to this organ as a median posterior branch of the uterus.

Nephridia.

The nephridia resemble those described by Beard (2), Wheeler (17), and v. Stummer-Traunfels (16) in other species. They have the form of a pair of bent tubes opening anteriorly into the dorsal coelomic space (text-fig. 22), and sloping outwards and backwards towards the ventral surface so as to come to run parallel with the alimentary canal (text-fig. 21); they open posteriorly by separate openings into the commencement of the rectum (text-fig. 19).

Along the greater part of their course the nephridia are of considerable diameter and are lined by large glandular cells with long cilia; they, however, narrow considerably towards their anterior ends, where the lining cells become much smaller and, as a matter of fact, the nephridial epithelium passes gradually into that of the coelom. In this respect I am in agreement with Maidl (12), who in a recent paper described much the same in *M. glabrum*.

The nephrostomes are situated on either side of and very close to the internal opening of the oviduct, although not quite in the same plane as this structure, being slightly dorsal to it; all three openings can, however, be seen in one horizontal section.

The nephridia contain numerous immature and fragmentary ova (text-fig. 21 C), but, like Wheeler and other investigators since Nansen, I have never seen complete, ripe ova in this situation.

The similarity in structure and position between the nephridial and oviducal openings in *M. costatum* is very striking, and has, perhaps, some bearing on the homologies of these organs. Nansen (15), who described a very similar arrangement in *M. carpenteri*, referred to them as three oviducts, and we must remember that before his discovery of the "lateral oviducts" Beard (1) had suggested that "the oviduct opening into the cloaca may perhaps originally have been formed from two segmental organs, for the cloaca is an epidermic invagination, and if it were obliterated the oviduct would open on the median line." That partial fusion of a pair of segmental organs can take place has been shown by Wheeler (17), who described the nephridia of *M. glabrum* as

possessing a single nephrostome as well as an unpaired end-piece opening into the rectum; a similar condition is to be found in *M. cryptopodium*, where, however, the median end-piece opens directly to the exterior on a papilla just under the cloacal orifice. Moreover, according to Wheeler, in *M. belli* the cloaca, oviduct, and nephridial end-piece open separately on the posterior surface by three ciliated apertures.

Beard's suggestion as to the nature of the oviduct was forgotten when the nephridia were discovered, and, whilst not wishing to commit myself to this theory, I recall it as one to be borne in mind. Perhaps *Protomyzostomum polynephris* will afford clues to a number of such problems in the morphology of this difficult group of animals.

MYZOSTOMA RUBROFASCIATUM v. Graff. (Pl. VI. fig. 1.)

M. rubrofasciatum v. Graff (8), p. 33, pl. ii.

In Mr. Crossland's collection are two specimens of a *Myzostoma* from Forculch Barrier Island, obtained from a Comatulid which unfortunately cannot now be traced.

The animals are of an oval shape, but, owing to the contraction of the bodies being accompanied by a curling-up of the anterior and posterior ends (*cf.* Pl. VI. fig. 1), it is impossible to give exact measurements. One specimen is a little larger than the other, and must have had a length of about $2\frac{1}{2}$ mm., with a maximum breadth of 2 mm.; the smaller specimen measures approximately mm. by 1.75 mm.

The body is of considerable thickness; on the dorsal side is a very conspicuous median longitudinal elevation running from one extremity to the other; narrow at each end, it is very broad towards the centre of the body, where it reaches a breadth almost one-fifth of that of the whole animal. From the sides of the median elevation arise seven to eight broad radial ones extending to the body-margin, where they end in short blunt processes. Between these primary radial "costæ" are a number of shorter secondary and tertiary ones, these are also of considerable breadth, and terminate in marginal processes.

The costæ are so numerous near the edges of the body as to come in contact with one another laterally, thus forming a thick ribbed margin, a very conspicuous feature of this species. As mentioned above, the body-margin presents a series of short blunt processes formed by the terminations of the radial elevations; there are between 25 and 30 pairs of these processes, which are very irregular in size and shape. In both specimens, however, the last pair and, to a slightly less degree, the penultimate and antepenultimate pairs, are considerably enlarged and thickened.

The coloration of the dorsal surface in the preserved specimens is peculiar and very characteristic; the median elevation and the costæ are of a yellowish colour; the rest of the dorsal surface is brownish, except where a pair of narrow light-coloured streaks

run longitudinally down the body, each about halfway between the middle line and the margin. Although expressed somewhat differently, it will be seen that this colour-pattern is practically identical with that described by v. Graff (8) in *M. rubrofasciatum*, a Myzostomid obtained from an unidentified Crinoid in the Red Sea at Tur, near Sinai. I think there can be no doubt that Mr. Crossland's two specimens must be referred to the same species.

v. Graff's description was based on a single individual, which was more brightly coloured than those I am describing, moreover, at first sight it seems to differ considerably in shape from those specimens. This difference is, in my opinion, due entirely to the mode of contraction, the body in v. Graff's specimen having the sides bent ventrally so as to give it the form of a boat, the median elevation representing the keel.

Owing to the state of contraction of his only specimen, v. Graff was not able to describe the ventral surface at any length. In the individuals collected by Mr. Crossland the ventral surface is yellowish in colour, and the central muscular mass prominent. The five pairs of parapodia are well developed and, as in *M. costatum*, without division into proximal and distal regions; they arise approximately halfway between the centre of the body and the margin.

There are four pairs of suckers of relatively large size with radially folded walls. They are in the normal position between the parapodia, and are situated close to the periphery.

Both mouth and cloaca are subterminal.

The male papillæ are not conspicuous; they have the form of short conical processes in the usual position lateral to the third pair of parapodial bases.

I did not feel justified in cutting sections as I had only two specimens of this species at my disposal, and neither seemed likely to yield good results. One individual was cleared in cedarwood oil, but owing to the thickness of the body revealed practically nothing of the internal organisation.

MYZOSTOMA CROSSLANDI, sp. n. (Pl. VI. figs. 2, 3; Pl. VII., & Pl. VIII. fig. 1.)

From various localities in the Red Sea Mr. Crossland obtained four specimens of a large elongated Myzostomid (Pl. VI. figs. 2, 3) which is evidently closely related to *M. nanseni* v. Graff, but sufficiently distinct, in my opinion, to justify the creation of a new species to receive it. This form, which I name *M. crosslandi*, is in certain respects intermediate between *M. nanseni* and *M. folium* v. Graff.

Of the four individuals one was found at Ul Shubuk on *Antedon savignyi*, another in Suez Bay at a depth of 10 fathoms on *Antedon serripinna*, whilst the other two were obtained from a Comatulid which I have been unable to trace.

As mentioned above, this Myzostomid is of comparatively large

size, the lengths of the specimens measuring 8·5, 8, 8, and 5 mm. respectively.

The bodies have a maximum thickness of about 1 mm.; owing to the fact that all four specimens were contracted with the sides incurved ventrally, it is impossible to give exact measurements of the breadths, these, however, I estimate as varying between 3 and 3·5 mm. in the different individuals.

The body-disc is rounded off anteriorly and posteriorly; it does not terminate in a point, as in *M. folium*. The thick body thins out gradually towards the edges, and has a narrow translucent margin which is finely notched, giving rise to a number of inconspicuous marginal processes ending in fine points.

The dorsal surface is smooth; a median longitudinal elevation is noticeable in three specimens, and is conspicuous only posteriorly in the region of the oviduct; on either side are feeble elevations corresponding in position to the parapodial insertions.

Mouth and cloaca are to be seen on the ventral side, situated on small papillæ and both close to the extremities, in this respect differing from *M. nanseni*, where the cloacal papilla lies at the commencement of the last quarter of the body. A narrow median ridge projects on the ventral surface, and marks the position of the stomach and rectum.

The parapodia are well developed and arranged in two almost parallel rows; the first pair lies close behind the mouth, but the insertions of the last pair are, as in *M. nanseni* and *M. folium*, at a considerable distance from the posterior termination of the body, this distance varying in the different specimens between a quarter and a third of the total length of the animal. Each parapodium is strong and, as in the two species just mentioned, consists of a broad muscular region, situated proximally, and of a narrower distal region provided with a conspicuous longitudinal groove on its ventral face.

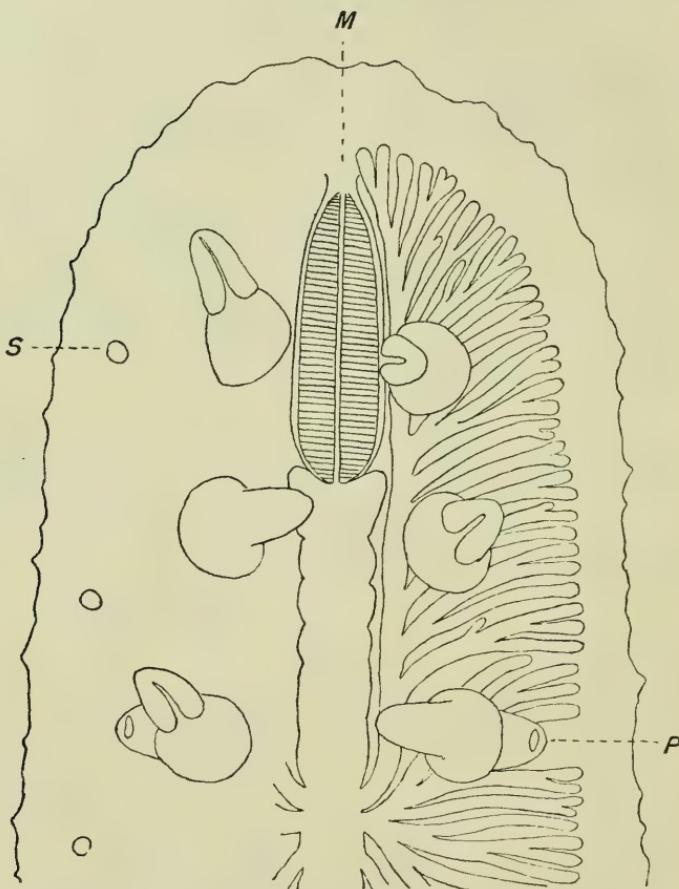
The male papillæ are inconspicuous and have the form of short conical processes in the usual position (text-fig. 23, p. 104). At first I thought that suckers were absent, and I could detect none under a low magnification; the use of a higher power of the microscope, however, revealed up to four pairs of these structures between the parapodia and close to the body-margin (text-fig. 23). They are much smaller than those described by v. Graff (9) in *M. nanseni*, and are, I think, in a vestigial condition.

The colour-pattern of *M. crosslandi* is quite characteristic; the dorsal surface in the spirit specimens varies from a greenish grey to a brown colour, with seven or more pairs of very narrow lighter bands running transversely across the body at regular intervals. I have no information as to the colour of fresh individuals.

Among a number of young specimens of *M. costatum* from Ul Shubuk I found two small individuals which I take to be young stages of *M. crosslandi*. They measure 1·25 × 1 mm. and 1 × .75 mm. respectively. The last pair of parapodia lies much closer to the posterior extremity of the body than in the specimens

just described, but, except for this and the proportions of length to breadth, they resemble the adults in every respect. Neither cirri nor suckers are better developed than in the latter, and, as a matter of fact, I could not trace any suckers at all in one of these young specimens.

Text-fig. 23.



Myzostoma crosslandi, sp. n.—Anterior part of the body; sketch made from a specimen cleared in cedarwood oil.

M. Mouth. P. Male papilla. S. Vestigial sucker.

No complete account of the anatomy of any of the large elongated Myzostomids has yet been published. I therefore used one of the larger specimens of *M. crosslandi* for the preparation of sections; when merely cleared in cedarwood oil they showed little more than just the peripheral parts of the alimentary canal.

A series of transverse sections was obtained, and they show a very characteristic feature of this species, namely, the great development of the "Hautmuskelschlauch," the muscle-sheath below the skin (Pl. VII., & Pl. VIII. fig. 1); it is best developed on the dorsal side of the animal, where it is separated from the outer epithelium by a cutis-like layer of connective tissue. This cutis is absent from the ventral surface, and here the muscle-sheath can be seen to consist of distinct outer and inner layers of transverse and longitudinal fibres respectively.

Alimentary Canal.

The mouth leads into a muscular elongated pharynx, which, when retracted, extends back in the body almost as far as the level of the second pair of parapodia. The pharynx was in this condition in all four specimens, and I was therefore unable to make out whether terminal papillæ occur. There is no distinct œsophagus, the pharynx leading directly into the stomach; this part of the alimentary canal is comparatively narrow and of considerable length; slightly sacculated anteriorly, it gives off on each side three intestinal trunks which arise close together at a point just posterior to the level of the third pair of parapodial insertions. The central of these three trunks branches profusely in the normal manner, but supplies only a small area of the body with intestinal caeca; the anterior and posterior trunks, however, continue in a straight course forwards and backwards respectively to the two extremities and, keeping close to the middle line, supply the rest of the body with numerous almost parallel branches given off from their external sides only. This peculiar and very characteristic arrangement of the intestinal branches (text-fig. 23) recalls that described by v. Graff in *M. elongatum* (7); it seems probable that it will be found to occur in all the elongated species.

The rectum commences a short distance behind the last pair of parapodia and runs backwards as a straight narrow tube, which opens on a small but conspicuous papilla (Pl. VIII. fig. 1) close to the posterior margin of the body.

I could find no trace of salivary glands in connection with the alimentary canal, and the peculiar glandular tissue described as surrounding the anterior part of the stomach in *M. costatum* is very poorly developed in this species.

Reproductive Organs.

The single specimen sectioned proved to be in an androgynous condition, and both sets of organs seemed equally developed.

Male Organs.

The testes (Pl. VII.) are embedded in the parenchyma, chiefly ventral to the alimentary canal, but a certain number of follicles, as in *M. costatum*, extend upwards between the intestinal branches

and come to occupy a dorsal position between or above the uterine cæca.

The testicular follicles are in some cases enclosed in small cavities which, in agreement with most recent workers, I consider to be cœlomic; these cavities are in places considerably enlarged, and are then filled with large masses of mature spermatozoa (Pl. VII. fig. 5); their size equals or exceeds that of the uterine spaces, which they resemble except for the nature of their contents. Some of these cavities seem to have lost their communications with the rest of the male organs, and I am at a loss to explain how the spermatozoa within them can make their way to the exterior.

Wheeler seems to have observed a somewhat similar condition of the male organs in his species *M. circinatum*, but in this form vesiculæ seminales and "penes" appear to be absent; in *M. crosslandi* the majority of the testicular follicles communicate with the vasa deferentia, and through these with seminal vesicles which open on to the short male papillæ.

Female Organs.

The female organs of *M. crosslandi* are very similar to those just described by me in *M. costatum*. The single pair of hollow ovaries (Pl. VII. fig. 1) lies ventro-laterally to the stomach just behind the point of origin of the first pair of intestinal trunks. The cavities of the ovaries communicate with a pair of narrow cœlomic tracts which run upwards along the sides of the stomach to join the small median cœlomic space from which the uterine branches are given off. The latter are numerous and relatively very slender; they follow the main ramifications of the intestine.

As in *M. costatum*, the oviduct communicates with the median uterine cœlom by means of a narrow ciliated duct, which in this species is rather long. The oviduct itself is very slender and much compressed so as to appear crescentic in transverse sections; it decreases in width considerably in the region of the rectum and opens on the cloacal papilla by a very narrow terminal tube.

Nephridia.

The nephridia (Pl. VII. figs. 2-5) occupy very much the same position as in *M. costatum*, and, as in that species, open posteriorly into the sides of the rectum close behind the commencement of that organ. Unlike *M. costatum*, the anterior ends of the nephridia do not communicate directly with the median uterine cœlom, but open separately into the narrow anterior end of the oviduct, so that the three tubes which afford communication between the cœlom and the exterior possess but a single internal opening.

The anterior terminal part of each nephridium has the form of a transversely set narrow tube lined with long cilia; this widens out laterally when the organ follows a rather sinuous course, backwards and downwards, and comes to form a broader tube

lying ventral to the stomach. The nephridia run side by side ventral to the stomach for a short distance, but in the posterior region of that organ slope upwards again, finally lying lateral to the rectum just before opening into it.

Nervous System.

I was able to make out very little of the nervous system of this species, as the peripheral nerves were only very poorly stained in my sections. The central nerve-mass was, however, distinct and occupied the same position as in other species, that is to say the centre of the body, in the region between the second and fourth pairs of parapodia.

This typical concentration of the central nervous system is a point of interest, since it shows that the elongated form of *M. crosslandi* is probably not a primitive character; the arrangement of the intestinal branches and other organs also indicates that this species is derived from some form possessing a more radial symmetry.

This is probably also true of allied species, such as *M. nansenii* and *M. folium*.

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EXPLANATION OF THE PLATES.

PLATE V.

Figs. 1-6. *Myzostoma costatum* F. S. Leuckart.—Series of specimens illustrating the variation in the shape of the body and the development of the costæ. The individuals shown in figs. 2 and 3 possess an abnormal number of parapodia (*cf.* p. 93). In all the figures *a* represents the dorsal, *b* the ventral aspect of the animal. $\times 12$.

PLATE VI.

Fig. 1. *Myzostoma rubrofasciatum* v. Graff.—Dorsal view. $\times 18$.

Figs. 2-3. *Myzostoma crosslandi*, sp. n.—Two specimens, dorsal and ventral aspects. $\times 12$.

PLATE VII.

Figs. 1-5. *Myzostoma crosslandi*, sp. n.—Transverse sections to show the anatomy. *c.n.* Central nerve-mass. *int.* Branch of intestine. *m.* Muscular sheath. *n.* Nephridium. *o.* Ovary. *on.* Oviduct. *r.* Rectum. *sp.* Mass of spermatozoa occupying cœlomic space. *st.* Stomach. *te.* Testis. *ut.* Branch of the uterus.

Fig. 1. Section passing through the ovaries.

Figs. 2-4. Sections passing through the anterior portion of the oviduct and showing the position of the nephridia.

Fig. 5. Section passing through the posterior parts of the stomach and oviduct.

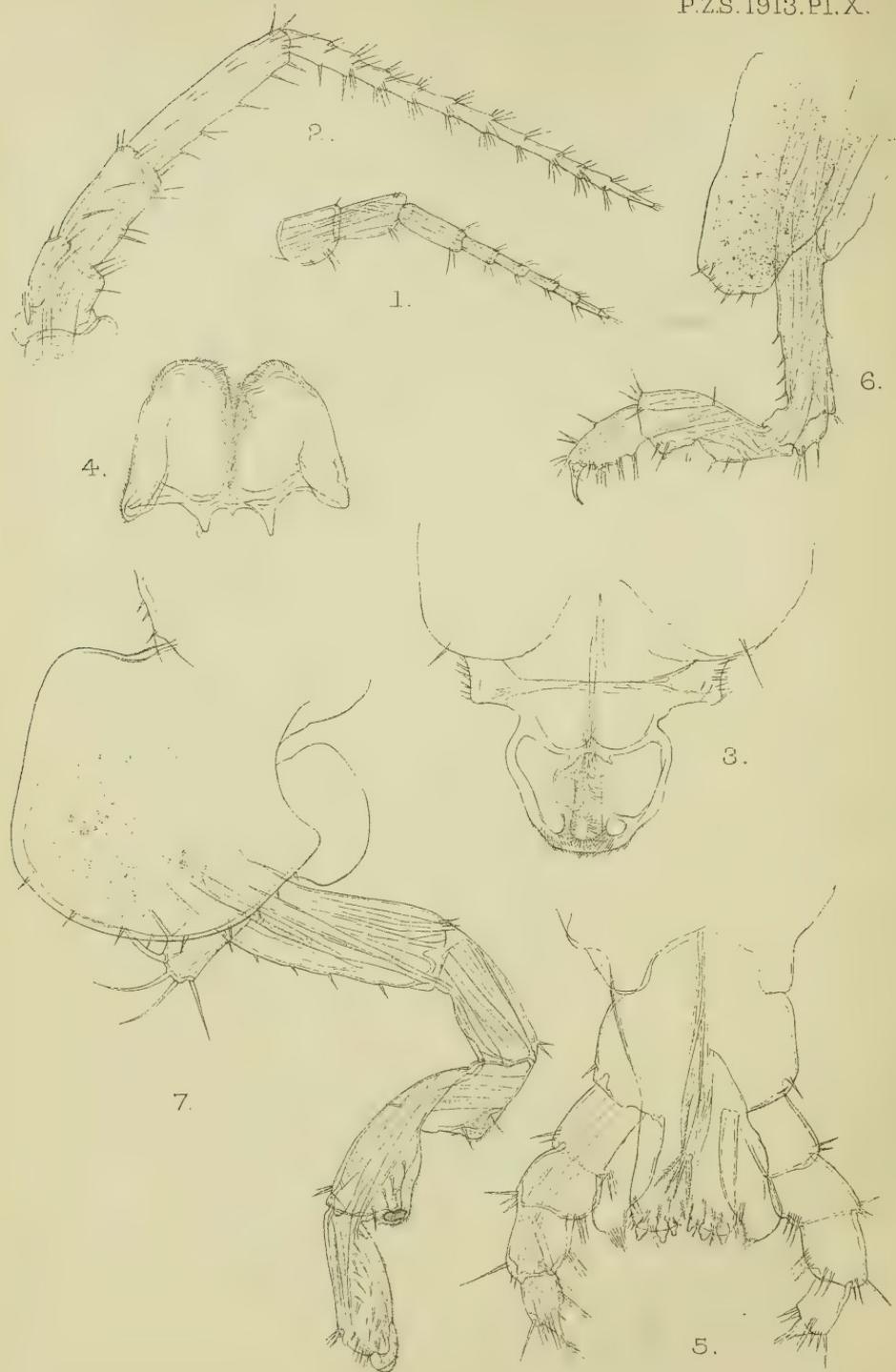
PLATE VIII.

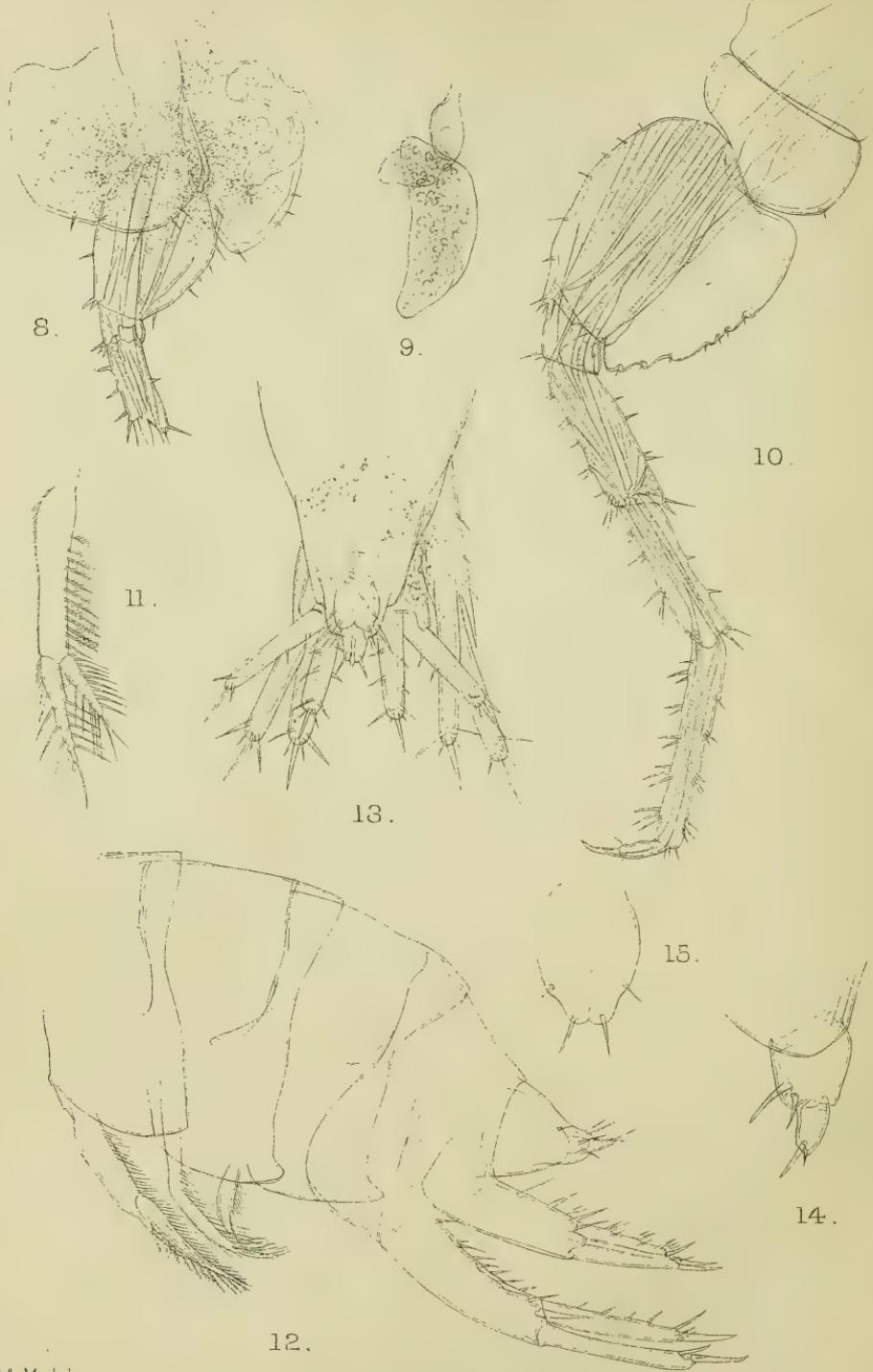
Fig. 1. *Myzostoma crosslandi*, sp. n.—Photograph of a transverse section through the posterior region of the body, passing through the cloacal papilla (*cl.p.*). Lettering as in Plate VII.

Fig. 2. *Myzostoma costatum* F. S. L.—Photograph of a longitudinal section showing the principal organs. *ph.* Pharynx.

Fig. 3. *Myzostoma costatum* F. S. L. Photograph of a transverse section passing through the anterior extremity of the stomach and showing the ring of glandular tissue (*gl.*) developed round the alimentary canal in this region.

Fig. 4. *Myzostoma costatum* F. S. L.—Part of the same section as fig. 2, under a higher magnification. *gl.* Glandular tissue.





P.A.M. del.

Hath, imp.

TALITRIATOR EASTWOODÆ.

8. Description of an Amphipod belonging to the Family Talitridæ, from the Woodbush, Transvaal. By PAUL A. METHUEN, F.Z.S.

[Received July 7, 1912 ; Read November 26, 1912].

(Plates X. & XI.*)

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<i>Talitriator</i> , gen. nov.	109
<i>T. eastwoodæ</i> , sp. n.	110

A few months ago I received from Miss Audrey Eastwood some Gammarids from streams near Mr. Eastwood's farm, Clearwater, in the Woodbush, Northern Transvaal. Seeing that these are the first Gammarids recorded from the fresh-waters of South Africa other than near the sea, they are of some little interest.

The specimens sent belong to one species and to a family whose members, though they are usually littoral marine forms, have often been recorded from localities far from the sea and at some considerable altitude in other countries.

Thus *Talitrus sylvaticus* has been found in Tasmania up to a height of 760 metres on Mount Wellington, and *Chiltonia* in New Zealand in mountain streams up to 450 metres and more. The genus *Hyalella* is restricted to fresh-waters, occurring according to Stebbing (in 'Das Tierreich') "in depths above the sea-level extending to 4053 metres"; thus in South America, Lake Titicaca supports a number of deep-water forms.

We can probably derive most of the fresh-water species in this family directly from marine ancestors. In the Cape some littoral marine forms do actually ascend for a short way up streams near the coast. But until this record from the Woodbush none had been discovered at any distance from the sea.

I think we can safely say that this new species has been independently derived from a marine form. Though a new genus has been made for its reception, yet it is very closely related to the genus *Talitrus*, in which genus it may have to be included eventually.

The fact that there is an Amphipod in this country which thrives in mountain streams at least in one locality is very suggestive as to what might be done to increase its numbers and range for the purpose of trout food ; and I think no one would dispute its value for this purpose.

Genus *TALITRIATOR*, gen. nov.

Diagnosis.—Like *Talitrus* except for the fifth side-plate and the following characters :—

Antennule is slightly shorter than peduncle of antenna. The

* For explanation of the Plates see p. 112.

fourth joint of the maxilliped is present. Gnathopod I not so long as gnathopod II and not stronger; fifth joint strong and swollen.

TALITRIATOR EASTWOODÆ, sp. n. (Pls. X. & XI.)

Length, not counting antennæ, with pleon bent 7·2 mm.; no striking difference between the male and female.

Antennule (Pl. X. fig. 1).—The third joint slightly the longest. On the surface each joint carries distally two fairly long bristles. On the upper surface opposite the ventral groups of setæ are groups of bristles, shorter than those borne ventrally, each group either of two or three bristles; on the basal joint a single bristle. The last segment, which is very short, carries two stiff bristles. The number of segments is nine or ten.

Antenna (Pl. X. fig. 2).—Penultimate joint of peduncle is nearly twice the length of the proximal joint; the distal nearly twice the length of the penultimate. All the segments of the flagellar part are provided distally with a whorl of bristles, there being four groups generally to each segment, three bristles to each group. The last segment ends in a compact group of fine bristles.

Upper lip (Pl. X. fig. 3) rounded, with numerous hairs at the extremity.

Lower lip (Pl. X. fig. 4).—The lobes with long and short setæ; the mandibular processes, which are fairly well developed, possess minute setæ.

Mandible.—Palp absent: otherwise normal.

Maxillula.—Much as in *Talitrus*, with nine claw-like toothed-bristles—five larger and four smaller—furnishing the outer plate. The inner plate with two setose spines, and a few hairs proximally along the inner margin. The palp exceedingly small, with hairs on outer margin; it is apparently two-jointed, the distal joint a minute glabrous blunted spine.

Maxilla.—As for *Talitrus locusta*, normal.

Maxilliped (Pl. X. fig. 5).—Inner plates are remarkable in that they are furnished with three glabrous acorn-shaped processes on each side; they bear also a number of setose spines. The palp is four-jointed.

Gnathopod I (Pl. X. fig. 6).—Coxal plate narrow, with a few spines of unequal size on the ventral margin; the other six joints armed with a few spines on both margins, longest on the fourth joint. Fifth joint swollen. Sixth joint with six stout, slightly curved spines on the posterior margin and one slightly smaller than the other six, together with small bristles at the base of most of these spines.

Gnathopod II (Pl. X. fig. 7).—Coxal plate excavate behind with conical projection; lower border armed with short stout spines. The second joint is not swollen or expanded; it is much longer than any of the other joints. The third joint is narrower than the second, slightly swollen about the middle of anterior

margin; two small spines on posterior margin distally. The fourth joint short, the shape of a rhombus, with setose cushion on posterior margin and two stout bristles just behind the cushion. The fifth joint longer than the third or sixth, broadest at its distal base, and expanded also about the middle; a setose cushion extending along nearly the whole of the free posterior margin; a thickened chitinous enlargement on the distal part of the cushion; four bristles just behind the cushion placed subequidistant apart. The sixth joint nearly as long as the fifth; the posterior margin also with minute setæ. Behind the setose part a number of stout bristles.

Pereiopod I.—Not quite as long as pereiopod II, the coxal plate like that of gnathopod II, excavate behind with conical process. The second joint linear; the third joint shortest and convex behind; the fourth joint linear, broadest distally; the fifth and sixth joints linear. The sixth joint longer and much narrower than the fifth; the last joint small, with claw.

All the joints with spines which are most numerous on the anterior margin of the appendage.

The costegites are rather small lanceolate structures which are twisted and bent inwards; each carries about ten setæ.

Pereiopod III (Pl. XI. fig. 8).—Coxal plate unlike the preceding, bilobed, with a few spines. The second joint swollen, posterior margin convex; the third joint short; the fourth and fifth joints subequal. The fourth joint broadest at its distal extremity and broader than the fifth. The sixth joint linear, narrow, and longer than the fifth. Spines most numerous on the anterior margin of appendage.

Pereiopod IV (Pl. XI. fig. 9): together with pereiopod V considerably longer than the other pereiopods. In general proportion like pereiopod III. The coxal plate is small. The second joint is expanded.

Pereiopod V (Pl. XI. fig. 10).—Coxal plate small and shallow; the second joint much expanded, the posterior border notched behind each small spine. Third joint very short. Fourth, fifth, and sixth joints linear. Numerous spines, especially on anterior margin of appendage.

The Pleopods (Pl. XI. figs. 11 & 12).—The first the longest; the third by far the shortest; the second is intermediate in size.

The Uropods (Pl. XI. figs. 13 & 14).—The first the longest; the second a good deal shorter, and the third minute.

The first and second uropods are armed with stout bristles; on the distal joints these bristles are curved at their distal ends. The distal end of the third uropod is armed with one stout and one very small bristle; it consists of two joints. The basal joint with one large and one smaller bristle.

The Telson (Pl. XI. fig. 15).—Simple, slightly divided at base. It bears two bristles on each side.

EXPLANATION OF THE PLATES.

Talitriator eastwoodæ, gen. et sp. nov.

All the figures have been drawn with the aid of a Camera lucida.

PLATE X.

- Fig. 1. Antennule.
 2. Antenna.
 3. Upper lip.
 4. Lower lip.
 5. Maxillipeds.
 6. Gnathopod 1.
 7. Gnathopod 2.

PLATE XI.

- Fig. 8. Pereiopod 3.
 9. Branchial appendage of Pereiopod 4.
 10. Pereiopod 5.
 11. Pleopod 3.
 12. Sketch of pleon, showing comparative size of appendages.
 13. Dorsal aspect of posterior part of body.
 14. Uropod 3.
 15. Telson.

9. The Genus *Engæus*, or the Land Crayfishes of Australia.

By G. W. SMITH, M.A., Fellow of New College,
 Oxford, and E. H. J. SCHUSTER, M.A., D.Sc., F.Z.S.,
 Fellow of New College, Oxford.

[Received August 8, 1912 : Read November 26, 1912.]

(Plates XII.-XXV.*)

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Systematic : Five new species of <i>Engæus</i>	118-126

INTRODUCTION.

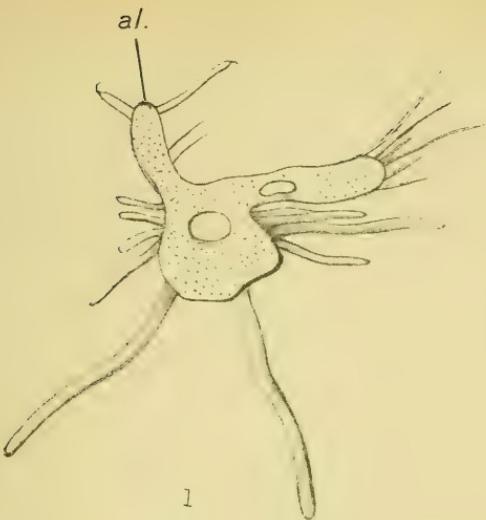
The existence of burrowing forms of Australian Crayfish, which live in underground tunnels excavated in damp soil, was first made known by Erichson, who described two species from Tasmania and placed them in a new genus, *Engæus*[†]. Besides the two Tasmanian species, a very large collection of these burrowing Parastacidae from Victoria has gradually accumulated in the collection belonging to the Melbourne Museum, chiefly through the activity of Messrs. Kershaw and Fulton, and the present memoir is founded on this large collection and also on specimens which one of us obtained in Tasmania in 1907-8.

Before proceeding to the description and classification of this

* For explanation of the Plates see pp. 126, 127.

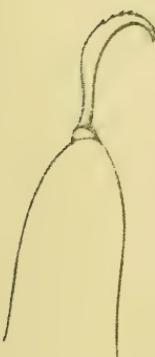
† Archiv f. Naturg. vol. xii. 1846, p. 102.

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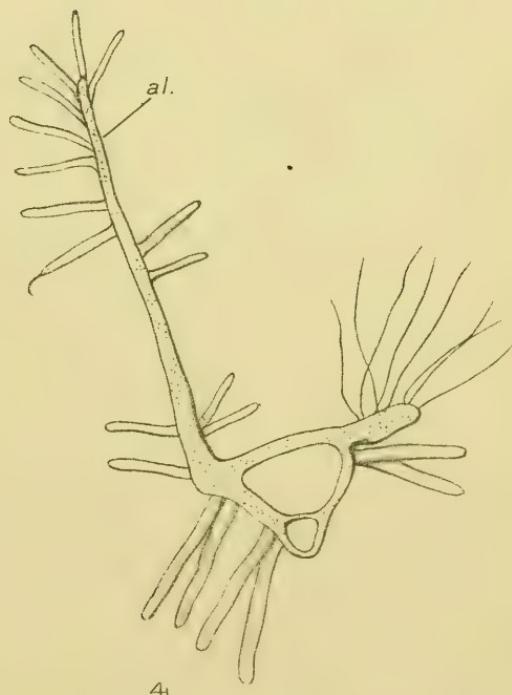


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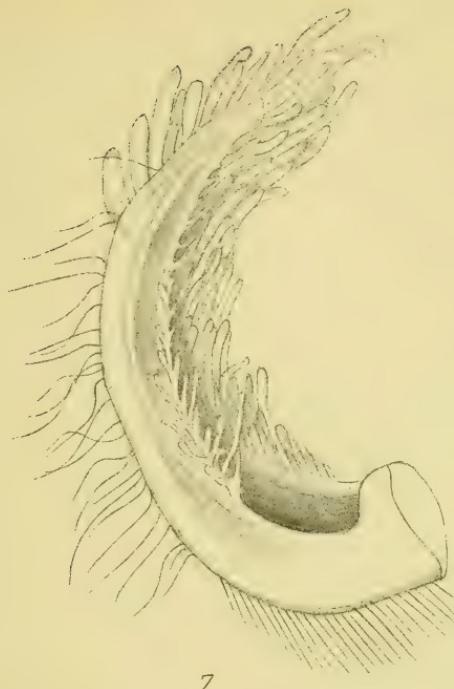


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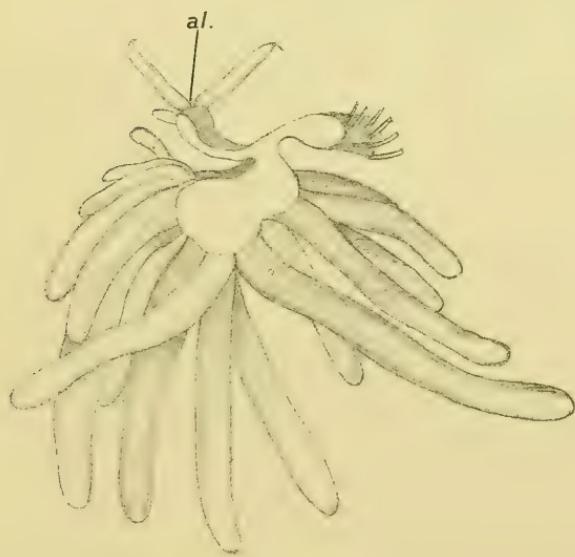
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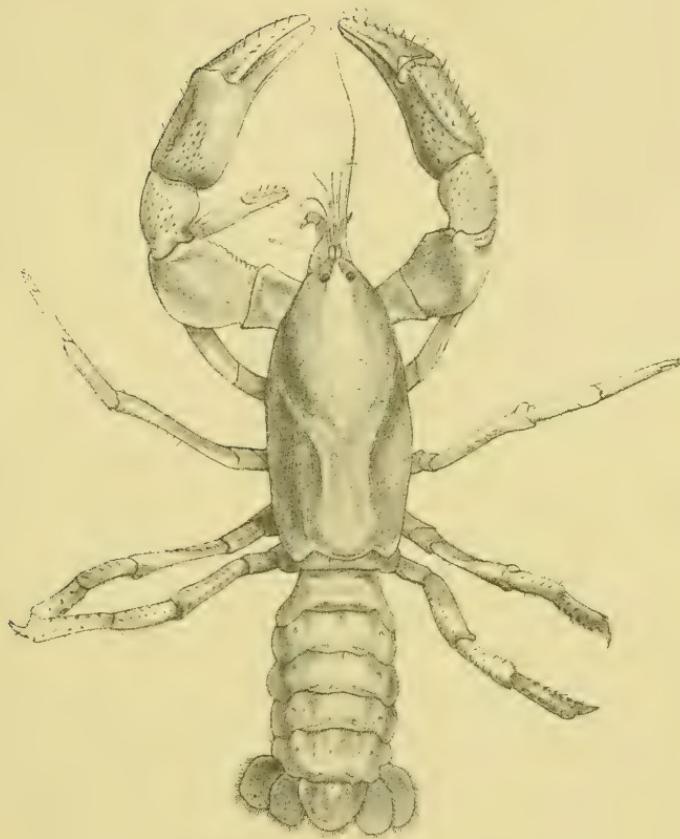


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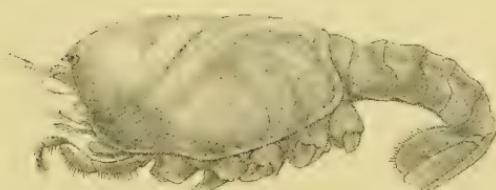


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GILLS OF *ENGÆUS CUNICULARIUS*.

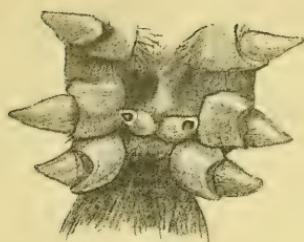


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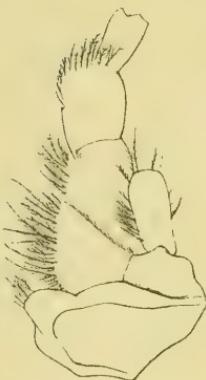


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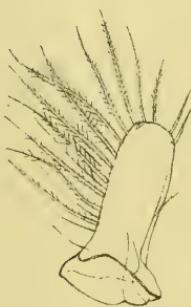
ENGÆUS FOSSOR.



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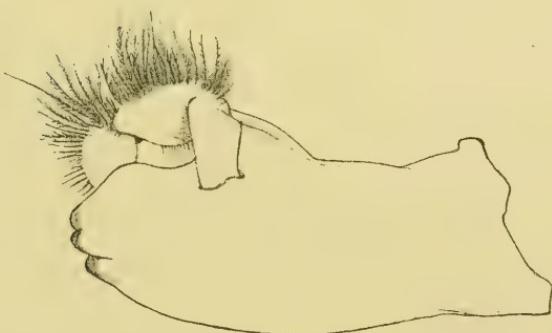
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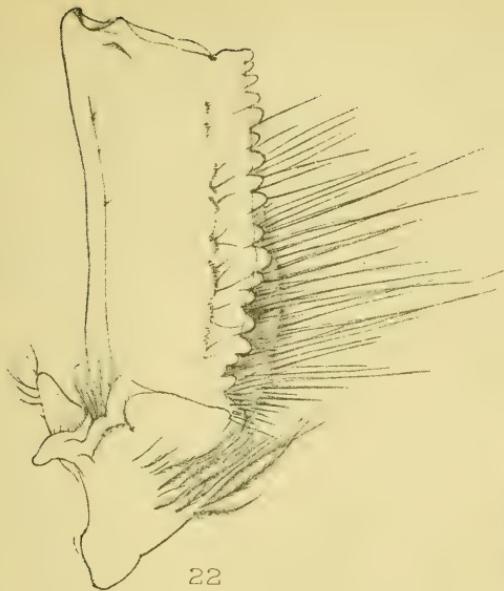
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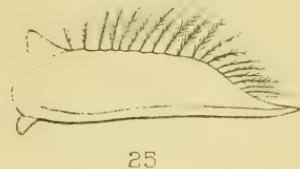
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ENGÆUS FOSSOR.



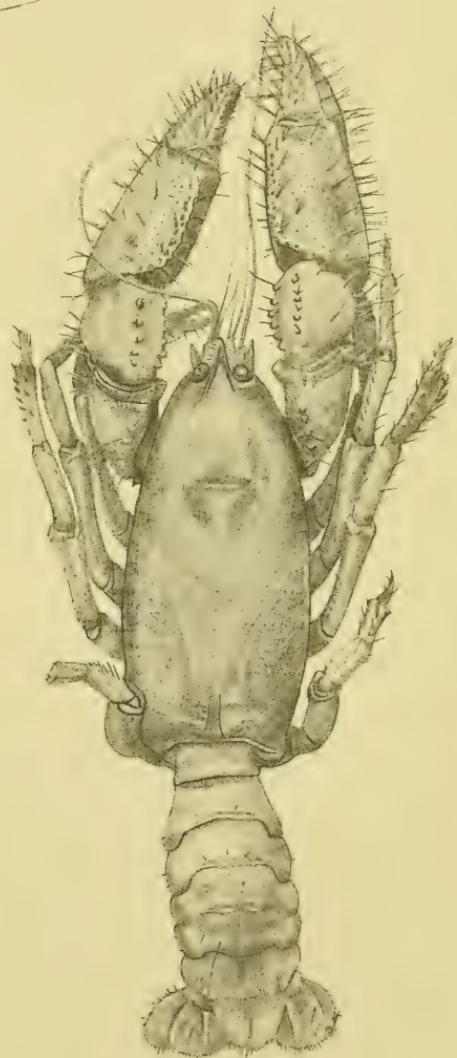
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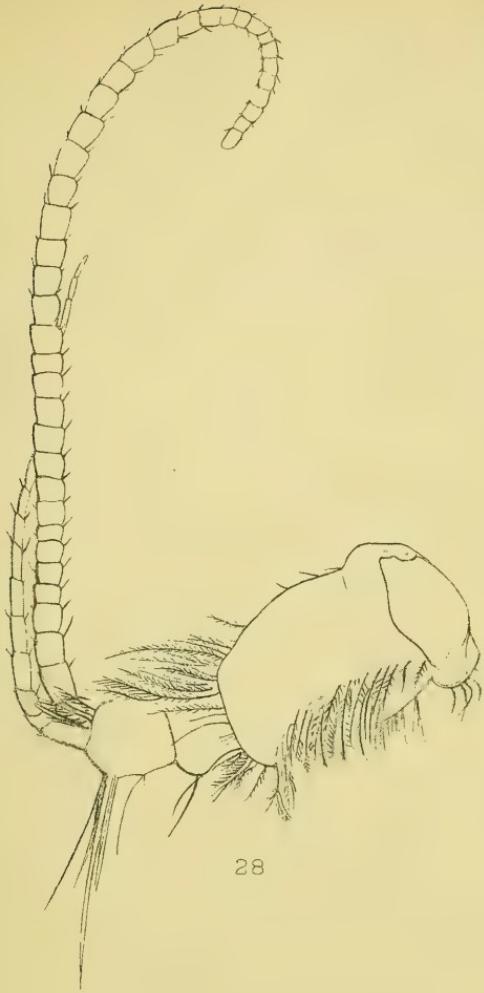
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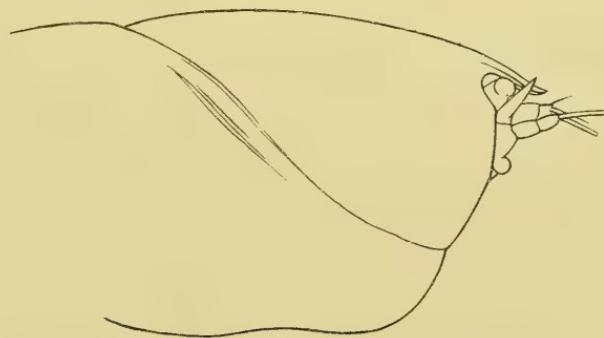
22. ENGÆUS FOSSOR. 23-25. E. AFFINIS.



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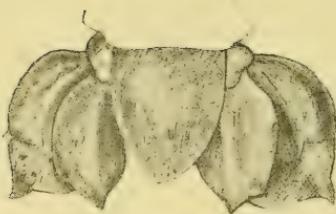
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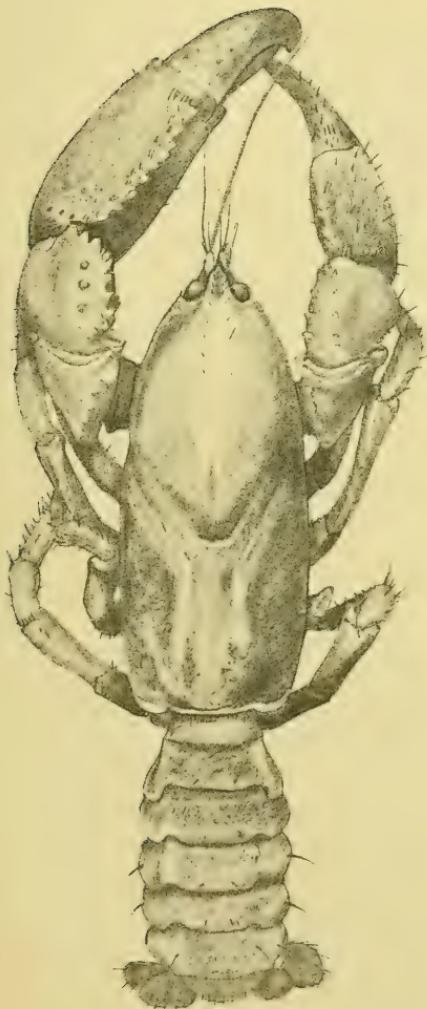
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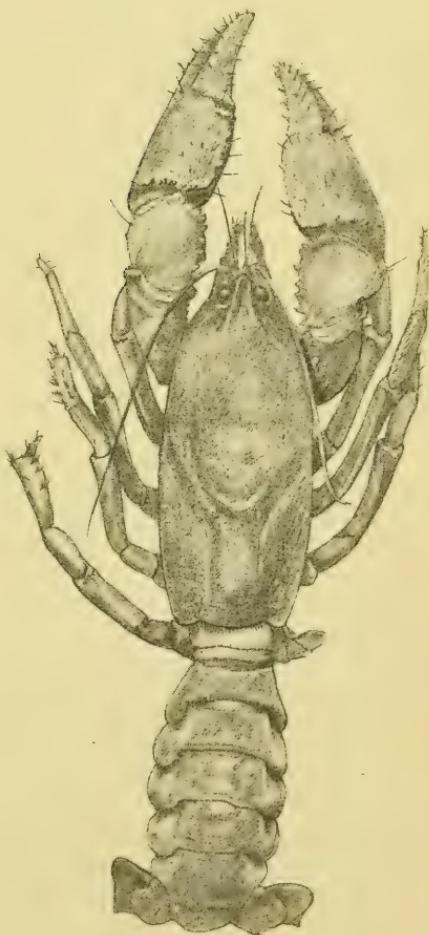
26. *ENGÆUS AFFINIS.* 27, 28. *E. VICTORIENSIS.*



31



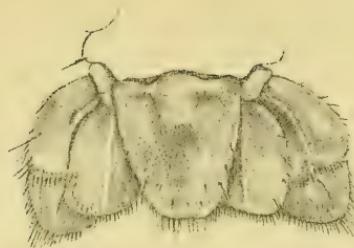
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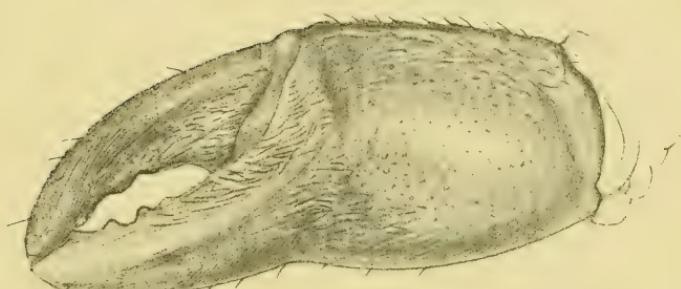
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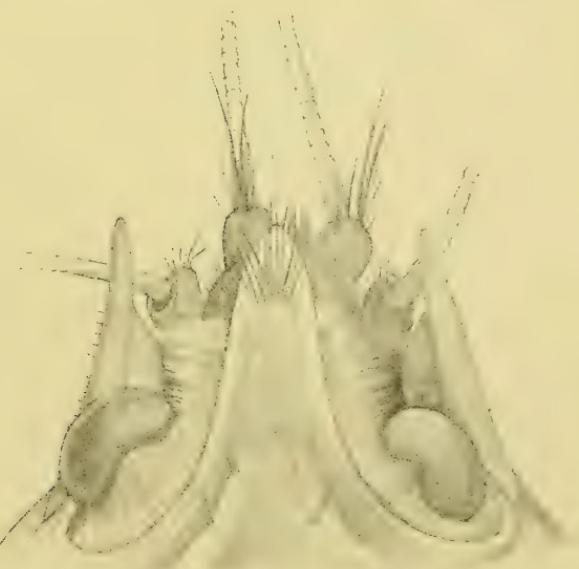
29. ENGÆUS VICTORIENSIS. 30, 31. E. PHYLLOCERCUS.



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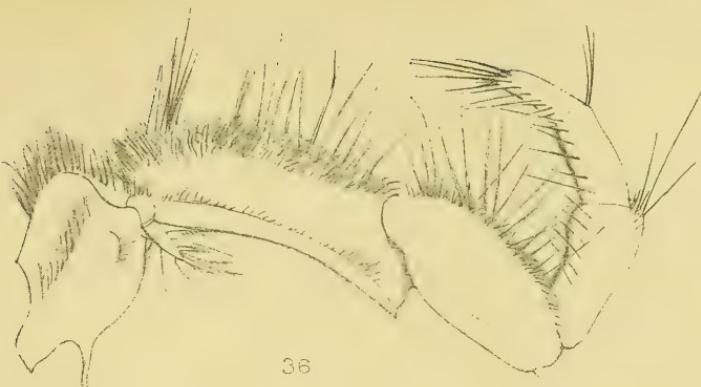
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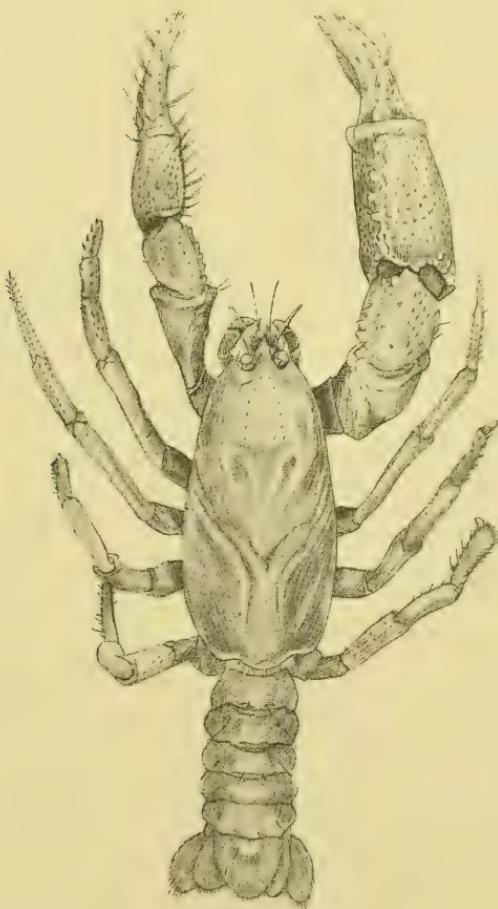
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32, 33. ENGÆUS VICTORIENSIS. 34. E. HEMICIRRATULUS.



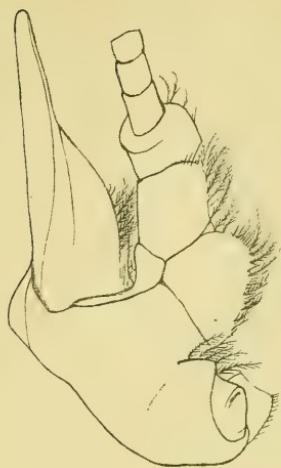
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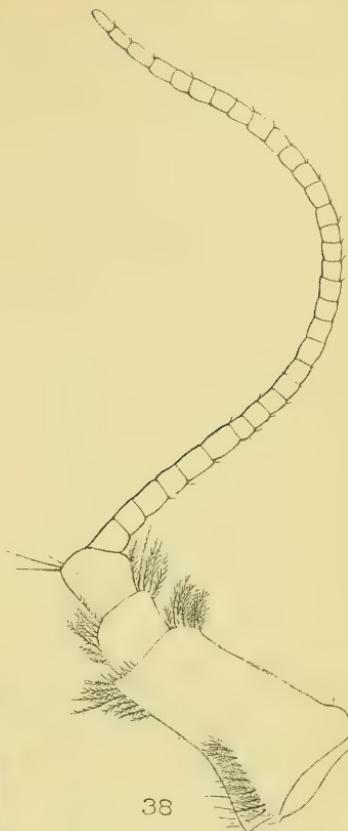
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35. ENGÆUS HEMICIRRATULUS. 36. E. PHYLLOCERCUS.



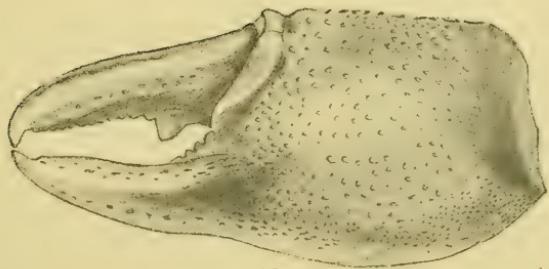
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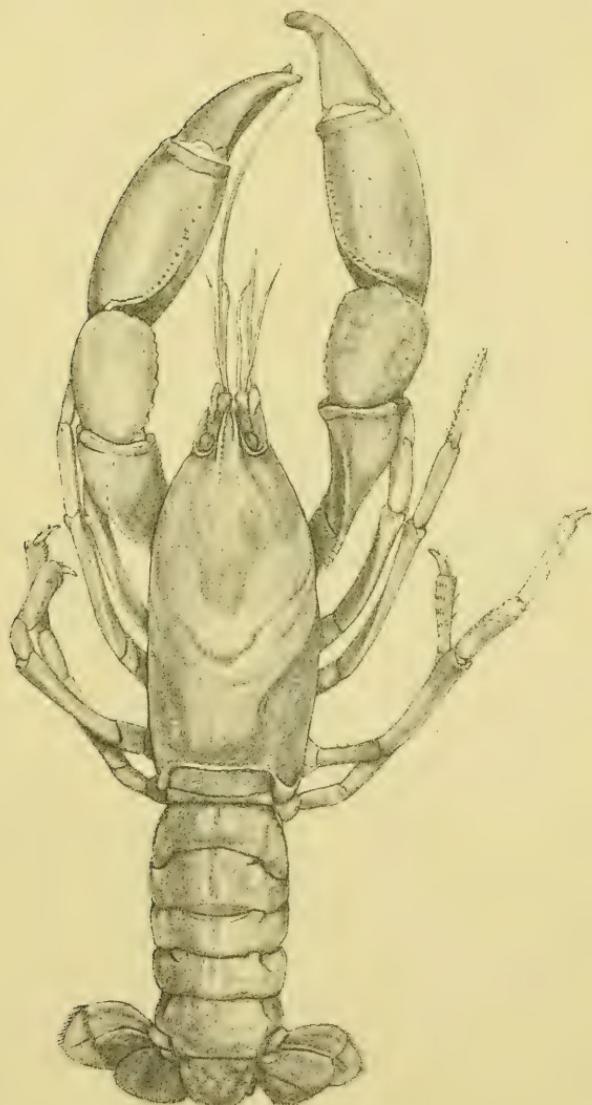
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37, 38. *ENGÆUS HEMICIRRATULUS*. 39-41. *E. CUNICULARIUS*.



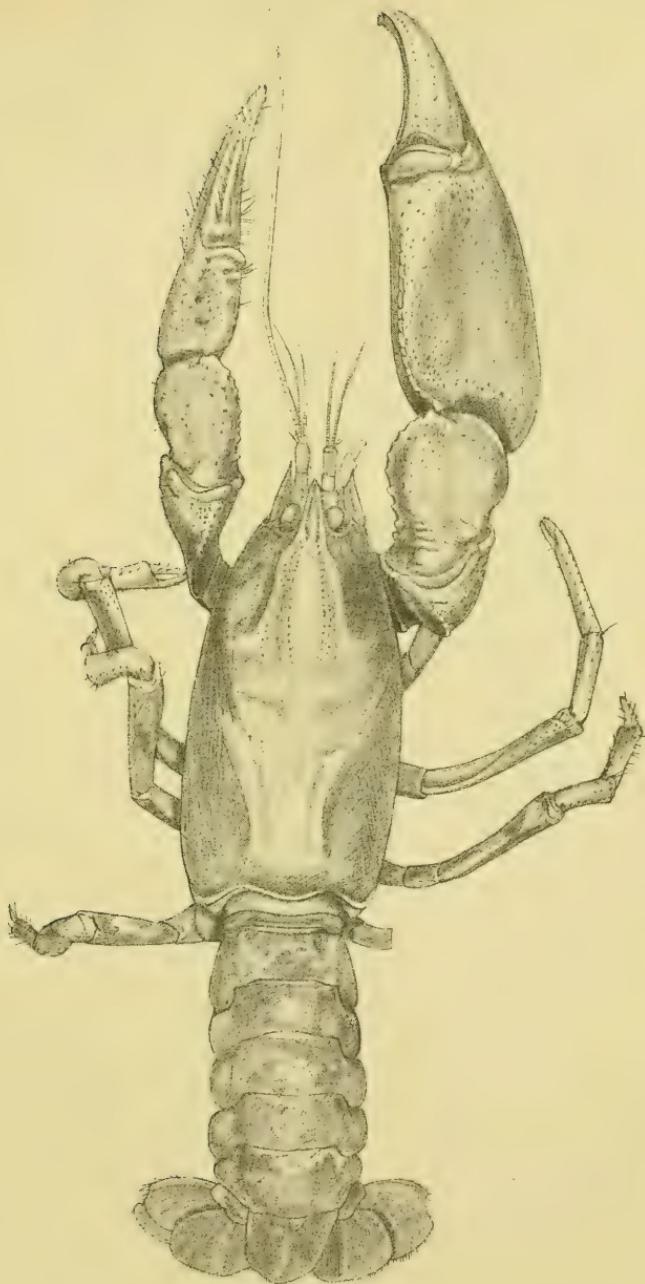
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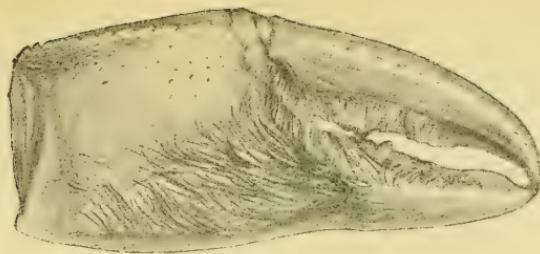
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ENGÆUS CUNICULARIUS.

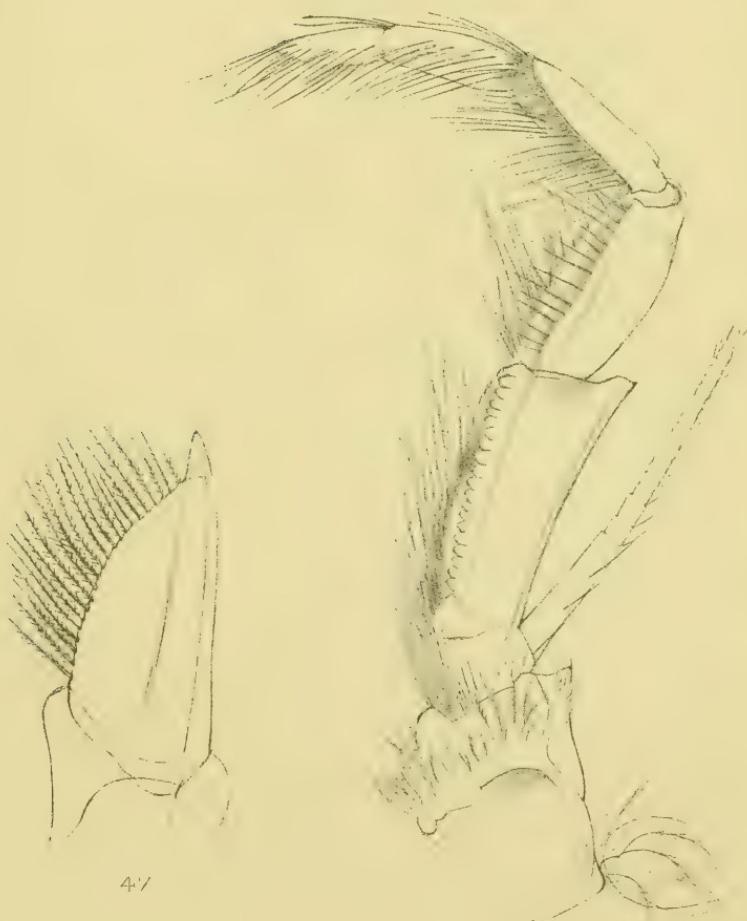


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ENGÆUS CUNICULARIUS, (WARRAGUL, GIPPSLAND).



45



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ENGÆUS CUNICULARIUS.

material, it is necessary to correct an error of interpretation, published in the account which one of us gave of the Freshwater Australian Crayfishes in the 'Proceedings of the Zoological Society' for March 1912 (p. 144). This account did not pretend to deal with the Land Crayfishes of the genus *Engaeus* except in a very general manner, but in treating of the geographical distribution and relationship of the Australian Crayfishes as a whole, certain statements were made as to the probable derivation of *Engaeus* from the freshwater form *Parachæraps bicarinatus*, which a more detailed study of *Engaeus* has shown to be entirely mistaken. Since the rectification of this error has an important bearing on the geographical distribution of the group, and clears up certain puzzling and unsatisfactory features of the problem, we feel it right to give it some prominence, in order to prevent the misconception spreading any further. In the memoir referred to, it is pointed out that there exist in Australia two distinct groups of Freshwater Crayfishes, the genus *Astacopsis* occupying Victoria, Tasmania, and New South Wales, *i. e.* the South-eastern portion of Australia, and the genus *Chæraps* occupying Western and Northern Australia and New Guinea, but nowhere mingling in its range with *Astacopsis*. In addition to *Chæraps* and *Astacopsis* with their distinct and limited distributions, there is a single form, the common *Parachæraps bicarinatus*, which is closely allied to *Chæraps* in all its anatomical features and is evidently a derivative from *Chæraps*. This form has spread from the West right into and across the Central Australian deserts, and is now found all over the Australian continent, mingling with *Astacopsis* in Victoria and New South Wales. It has not, however, penetrated into Tasmania or New Guinea, which is strong evidence in favour of its being a comparatively modern derivative from *Chæraps*.

As *P. bicarinatus* is accustomed to live in small water-holes in the desert, it has taken on a wandering and burrowing habit, and is frequently found walking about in fields in search of some moist ditch or water-hole.

Now, it seemed probable that the genus *Engaeus*, containing the burrowing land forms, and confined in its distribution to Victoria and Tasmania, had been derived from *Parachæraps bicarinatus*, through an intensification of the habit of leaving the water and burrowing in damp soil. This idea was further confirmed by the curiously close resemblance which some of the *Engaeus* bear to *Parachæraps bicarinatus* in external appearance. It was therefore too confidently stated in the memoir referred to that *Engaeus* was probably a derivative of *Parachæraps*. Nevertheless, there was a very puzzling feature pointed out, supposing this derivation to be true, viz., that whereas *Engaeus* is represented in Tasmania by two species, the supposed parent form, *Parachæraps bicarinatus*, is entirely absent from that island, so that it was necessary to introduce one of two rather improbable hypotheses, either that *P. bicarinatus* once existed in Tasmania and is now extinct, or

else that the two species of *Engæus* have been somehow transported across Bass' Straits by accidental means.

Now, it transpires as the result of a detailed examination of the various species of *Engæus*, especially in respect to the structure of their gills, that the derivation of *Engæus* from *Parachæraps* is entirely false, and that the superficial resemblance of these forms to one another is due to convergence. On the other hand, it is abundantly evident from the gill characters that *Engæus* is a derivative of *Astacopsis*, and has nothing to do with either *Chæraps* or *Parachæraps*. The reasons upon which this conclusion is based are as follows. In *Astacopsis* the podobranchia do not possess a broad ala or wing-like expansion of the stem of the gill; the ala is, on the contrary, reduced to a mere rudiment, as shown in the transverse section (Pl. XII, fig. 1). Attached to this rudimentary ala of the podobranchs are a few gill-filaments, which are furnished at their tips with characteristically shaped hooks (fig. 2). All the other gills in *Astacopsis*, exclusive of the podobranchs, *i.e.* the arthrobranchs and pleurobranchs, have their filaments entirely free from terminal hooks. The peculiar hooked setæ present on the bases of the podobranchs in *Astacopsis* also have a constant and characteristic shape, the terminal hooks being not sharply recurved (fig. 3). Now all the above characters are absolutely constant for the various species of *Astacopsis*. In *Chæraps* and *Parachæraps*, on the other hand, we have a totally different series of gill characters which are just as constant and characteristic for all the species of these two closely related genera. In these forms the podobranchia possess a very broad ala (fig. 4) which is furnished with numerous filaments, whose hooks have a characteristic sickle shape (fig. 5). In all the other gills, besides the podobranchs, numerous filaments are provided with these terminal hooks. Finally, the hooked setæ (fig. 6) on the podobranchs have an entirely different shape compared with those of *Astacopsis*, being sharply recurved at the ends.

Now, the distinctive character and absolute constancy of these gill-structures force us to attach especial taxonomic importance to them, far more importance than external appearance or other characters which fluctuate from species to species, so that an examination of the gills of *Engæus* should give us the key to its relationship with the other genera. *The gills of Engæus agree in all the above particulars with those of Astacopsis, and differ entirely from those of either Chæraps or Parachæraps* (Pl. XIII, figs. 7-10). Thus the podobranchs possess a rudimentary ala (figs. 7, 8) which carries a few filaments, and these filaments terminate in hooks (fig. 9) shaped like those of *Astacopsis*. The gills other than the podobranchs have their filaments unprovided with hooks; the hooked setæ (fig. 10) on the podobranchs are not sharply recurved at the end, but are shaped as in *Astacopsis*.

Now, apart from the gills, *Engæus* differs so widely from both *Astacopsis*, *Chæraps*, and *Parachæraps* in the characters of its bodily structure, appendages, etc., that these no longer serve as a

guide, and the resemblance to *Parachæraps*, which proved at first deceptive, consists merely in the absence of spines and ridges on the body and the hairiness of the mouth appendages, which are evidently due to convergence following on the similar mode of life.

As a matter of fact, in a certain number of anatomical features, besides the gills, *Engæus* agrees rather with *Astacopsis* than with the other two genera: thus the penultimate segment of the second maxillipede projects nearly as far forward as the terminal segment, and the vas deferens is situated on a short simple papilla.

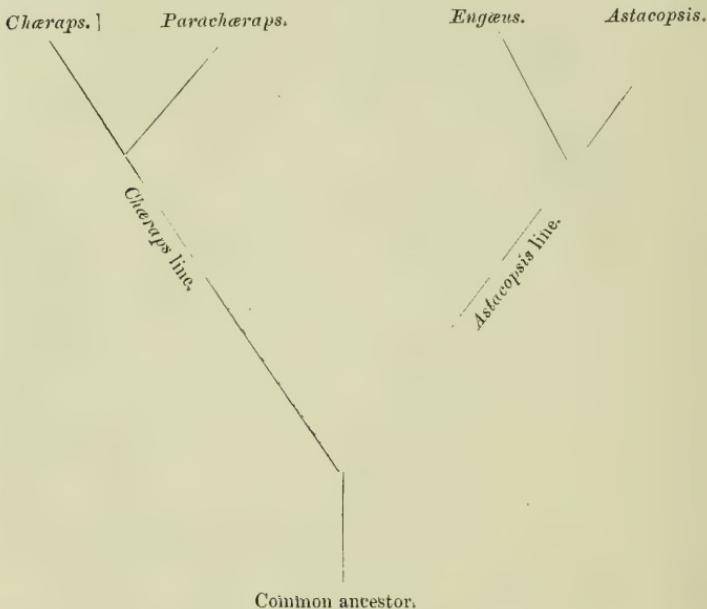
We therefore have no hesitation in claiming that *Engæus* is a derivative of *Astacopsis* or of a close ancestral form of *Astacopsis*, and is fundamentally distinct from the western *Chæraps* and its widely distributed derivative *P. bicarinatus*.

It may be pointed out that this conclusion is far more intelligible, on general grounds, than the original derivation of *Engæus* from *P. bicarinatus*, and it clears up all the puzzling features in the geographical distribution of these forms. We can now clearly explain why *Engæus* occurs as two species in Tasmania, although *P. bicarinatus* is absent, because *Astacopsis* occurs in Tasmania. It was also rather unaccountable that *P. bicarinatus*, being a comparatively recent derivation from *Chæraps*, which had not been able to penetrate into New Guinea or Tasmania, should have been able to give rise to several widely divergent species of *Engæus* distributed through Victoria and Tasmania. We can, however, easily see that if *Engæus* is a derivative from the much more ancient *Astacopsis*, that there has been ample time for its divergence into several species, and its distribution in Tasmania and Victoria alongside the parent *Astacopsis*, though occupying a totally different station, is perfectly intelligible.

To sum up the relationships of the Australian Crayfishes as a whole. The western and northern genus *Chæraps* and the south-eastern genus *Astacopsis* have been isolated from one another completely since a very ancient date, and at the present time they nowhere intermingle. *Chæraps* sent a northern straggler into New Guinea and the Aru Islands at a time when these islands were connected with the mainland (*C. quadricarinatus*), and *Astacopsis* has a typical representative in Tasmania, so that this genus in very much its present condition must have been present in Southern Australia at any rate when Tasmania was joined to the mainland. During this period, namely, when Tasmania was joined to the mainland, *Astacopsis* gave rise to the burrowing Land Crayfishes, *Engæus*, which are now represented by several species in Victoria and by two species in Tasmania. Subsequently to the separation of New Guinea and Tasmania from Australia, the western *Chæraps* gave rise to an offshoot, *Parachæraps bicarinatus*, which, forsaking the rivers as a necessary habitat, took to its wandering, pond and water-hole frequenting mode of life, and was thus enabled to spread across the desert regions and invade the territory of *Astacopsis* in the south

and east. Thus *P. bicarinatus* is now found everywhere on the Australian continent, but it has not been able to reach New Guinea or Tasmania, since these countries were cut off from the mainland when *P. bicarinatus* arrived.

The relationships of the Australian Parastacidae should therefore be expressed as follows, in place of the diagram given in the former memoir :—



2. Structure, Habits, and Interrelationships of the Species of *Engæus*.

The several species of *Engæus* are characterised by the great depth of the carapace, measured dorso-ventrally, and by its arched roof-shaped form. The eyes are small, and the abdomen tends to be reduced in size. We also note a greater hairiness of the mouth-parts and neighbouring regions, a feature probably correlated with the necessity of filtering the water in their burrows, which is usually very muddy. The gills, especially the arthrobranchs, tend to be reduced in size, and though the gill formula may be the same as in the other Australian Parastacidae, yet in certain forms the last pleurobranch is altogether suppressed. This entire suppression of a gill, which is unknown in any of the other Australian Crayfishes, is only one example of the very striking morphological changes which the species of *Engæus* may exhibit; and it may be truly said that the species of this genus are often separated from one another by greater differences than those which distinguish the genera of the Parastacidae from one another.

Thus, in one series of forms, *E. fossor*, *affinis*, *victoriensis*, *phylocerus*, *fultoni*, and *hemicirratulus*, the exopodite of the third maxillipede may be rudimentary or entirely suppressed; in another series the outer flagellum of the first antenna is absent (*E. hemicirratulus*), while the antennary scale and the uropods undergo striking changes in certain species.

It is difficult to find the reason for these marked aberrations of structure, but it may be pointed out that all of them are in the nature of losses or suppressions, *e. g.* the loss of the pleurobranch, the loss of the exopodite of the third maxillipede, the loss of a flagellum on the antennule, the reduction of the antennary scale, and the abortion of the eyes; and it may be plausibly argued that the underground, burrowing habit which removes the animal from active competition with other water forms has permitted degenerative changes which have no special adaptive meanings.

Another interesting point is the extraordinary variability of the large chelæ in these forms, and their frequent asymmetry. It appears to us extremely doubtful whether these variations indicate specific or only individual differences, since hardly two forms coming from the same locality and identical in other respects are ever quite alike in regard to their chelæ, and very often they differ fundamentally in this respect, independently of sex and size.

Unfortunately, we do not know very much about the habits of these burrowing crayfish, and the only personal observations were made by one of us in Tasmania on the smaller Tasmanian *Engaeus*, *E. fossor*.

This species is widely distributed in Tasmania, being found on the southern mountain ranges, on the north coast, and in the forests on the west coast. The burrows of the animal could be recognised as little round holes in the damp ground, sometimes near the banks of a stream or water-course, but very frequently far removed from any water in the middle of the forest in some damp situation. The burrow descends vertically into the ground, or if it is in a bank it is frequently horizontal, and after passing inwards for a foot or two it ends in a circular chamber which is always full of water. *Engaeus fossor*, when freshly taken from its burrow, has a rather soft whitish skin with brilliant blue patches and an occasional tinge of red. In one place near the Magnet Mine on the west coast of Tasmania, the banks of an artificial water-course which was used in the mining operations were completely riddled by the burrows of *Engaeus fossor*, and the foreman of the mine told me that these creatures were a source of continual damage and danger in works of this kind.

It is stated in Erichson's original memoir, on the authority of Herr Schayer, who collected the specimens, that *Engaeus* if kept in water soon dies. In view of the fact that there is always water at the bottom of the burrows, and also from what I have heard from people in Tasmania who have kept the animals in captivity, this statement may be received with some scepticism.

Since the animals are never seen out of their burrows in the day-time, very little is known as to their food or the means they employ to obtain it, but it is probable that they are mainly carnivorous in diet, as the remains of earthworms, insect larvae, and probably land Crustacea have been found in their stomachs. As has been pointed out elsewhere ('A Naturalist in Tasmania'), the evergreen beech forests in Western Tasmania support a very rich terrestrial fauna of land Amphipods (*Talitrus*) which swarm under the fallen beech leaves and timber, and numerous Myriopods and insect larvae occur as well, affording abundant food in exactly the situations which *Engaeus* chooses for its burrows.

The young are brought into the world and tended by the female parent in the same way as in the ordinary crayfish, and I have obtained females from their burrows with their young ones still attached to the swimmerets under the abdomen. At this stage the young ones have all the characteristic features of the adult, showing the same vaulted carapace and reduced abdomen.

The interrelationships of the various species of *Engaeus* may be gathered from the key for the determination of the species given on p. 119.

The least modified and specialised species is *E. cunicularius* from Tasmania, Gippsland, and Victoria. This species has the general form of the thorax and abdomen in a less aberrant condition than the other species, and it is also more normal in its other characters, possessing the last pleurobranch, the exopodite on the third maxillipede, and the two flagella on the first antenna in a fully developed condition. *E. fultoni* from Victoria is closely related to this species, but the exopodite of the third maxillipede is rudimentary.

The Tasmanian *E. fossor* and the Victorian species *E. affinis*, *victoriensis*, and *phyllocercus* are all closely related, and exhibit to the full the peculiarly roof-shaped thorax and reduced abdomen; while *E. hemicirratulus* is the most highly specialised, having lost not only the exopodite of the third maxillipede but also the posterior pleurobranch and the inner flagellum of the first antenna.

Genus *ENGÆUS*.

Erichson, Archiv f. Naturg. vol. xii. p. 102 (1846); Huxley, P. Z. S. 1878, p. 769.

The gill-formula is the same as in *Astacopsis*, *Cheraps*, and *Paracheraps*, except that the last pleurobranch may be entirely absent. The posterior arthrobranches are reduced in size.

The ala of the podobranchs (Pl. XIII. figs. 7 & 8 *al.*) is small and inconspicuous as in *Astacopsis*, and it carries a few filaments with terminal hooks which are shaped as in *Astacopsis*.

None of the other gill-filaments carry terminal hooks.

The hooked setæ on coxopodites and podobranchs are not sharply recurved, but resemble those of *Astacopsis*.

The mandibles (Pl. XV. figs. 16 & 17) have two prominent

median teeth and one smaller tooth in front, and a row of smaller serrations behind.

The first maxillæ (Pl. XVI. figs. 18 & 19) have the endopodite without any trace of a flagellum.

The second maxillipede has the penultimate segment broad, projecting nearly as far as the terminal segment (fig. 21).

There is an entire absence of filaments from the epipodite of the first maxillipede.

The third maxillipede may have the exopodite normal, reduced, or absent. There is a great development of filtering apparatus of bristles and hairs on this and on all the mouth-parts.

The great chelæ show an immense range of variation, being symmetrical or asymmetrical, serrated or smooth, hairy or comparatively hairless,

The vas deferens is situated on a simple short papilla.

The rostrum is reduced, and its lateral keels are either smooth or feebly tuberculated. There are no keels on the carapace, nor are there any spines on the carapace or abdomen. The abdomen is reduced, sometimes markedly so, and it may be hairy.

The eyes are reduced in size.

The carapace is very deep (Pl. XIV. fig. 12) measured in a dorso-ventral direction, and the distance from the tip of the rostrum to the cervical groove is always longer than that from the cervical groove to the posterior border of the carapace.

Key to the Species of the Genus Engæus,

(1) Last pleurobranch present, two flagella on 1st antenna.

(A) Exopodite of 3rd maxillipede absent or rudimentary,

Antennal scale rounded at end without spine	<i>E. fossor.</i>
Antennal scale pointed, last pleurobranch large	<i>E. affinis.</i>
Antennal scale pointed, last pleurobranch reduced	<i>E. victoriensis.</i>
Uropods produced into pointed apices	<i>E. phyllocercus.</i>
Rostrum straight and large with prominent keels	<i>E. fultoni,</i>
	<i>E. cunicularius.</i>

(B) Exopodite of 3rd maxillipede well developed

(2) Last pleurobranch and exopodite of 3rd maxillipede absent and only one flagellum on first antenna.....

E. hemioirratulus.

ENGÆUS FOSSOR Erichson, (Pls. XIV.-XVII. figs. 11-22.)

Astacus (Engæus) fossor Erichson, Arch. f. Naturg., vol. xii. p. 102 (1846).

Astacus fossor Von Martens, Monatsber. Akad. Wiss. Berlin, 1868, p. 618.

Engæus fossor Haswell, Cat. Australian Museum, Stalk- and Sessile-eyed Crustacea, p. 178 (1882).

The posterior pleurobranch is present, and is larger than the others. The anterior pleurobranch is very small.

The posterior arthrobranchs are all very small, consisting of a stalk bearing not more than four or five filaments.

The exopodite of the third maxillipede is reduced to a very small tubercle (Pl. XVII. fig. 22).

The antennal scale is rounded at the end and carries no terminal spine (Pl. XV. figs. 14 & 15).

The inner flagellum of the first antenna is slenderer than the outer one and about two-thirds its length.

Tubercles on propodite and ischiopodite of chela very inconspicuous.

The great chela always has a row of tubercles on the upper border of the propodite, the lower border being generally smooth and rounded. There is one prominent tooth on the inner surface of the dactylopodite, while there are three teeth on the lower part of the pincer. In some specimens the chelæ are equal in size and shape, in others one chela is more slender and hairy, and with the pincer more delicate and elongated.

In the female there is a pair of sperm-receptacles with conspicuous openings on penultimate segment (Pl. XV. fig. 13).

The eyes are small, and the rostrum is short with rather prominent keels. Contour of forehead shown in fig. 12 (Pl. XIV.).

The thorax is laterally compressed and highly arched. It is fairly free from hairs, but the abdomen is rather hairy.

The tail-fan is rounded without conspicuous spines or ridges.

Colour. Ground-colour ivory with blue and red blotches irregularly disposed.

Length 38 mm.

Locality. Magnet Mine, West Coast of Tasmania. Also reported to occur on the southern ranges. Confined to Tasmania.

Local Variety. Some specimens obtained from burrows near Muddy Creek, Bridport, on the north coast of Tasmania, while agreeing essentially with the above description, show certain variations. The whole body and limbs are more hairy, and this is especially marked on the chelæ. The propodites of the great chelæ are slightly tuberculated on their lower as well as on the upper border, and the chelæ tend to be slightly more elongated than in the type specimens. The keels on the rostrum are slightly more pronounced, and the eyes are a little larger.

ENGÆUS AFFINIS, sp. n. (Pls. XVII. & XVIII. figs. 23-26.)

All the pleurobranchs are of approximately the same size, the posterior pleurobranch being well developed.

The exopodite of the third maxillipede is absent.

The antennal scale ends in a well-developed terminal spine and an inner lobe which is not markedly produced (Pl. XVII. fig. 25).

First antenna is formed as in *E. fessor*.

There are two conspicuous rows of tubercles on the inner surface of the carpopodite of the great chela, and a row of marked tubercles on the meropodite. There is a row of tubercles on the upper border of the propodite, the lower border being smooth and rounded.

There is, as usual, great variability in the size and shape of the chelæ, in some specimens the two chelæ being similar and equal in size, while in others one chela, either the right or left, is

greatly enlarged. It is a general rule that the enlarged chela (fig. 24) in this species has a broad and short propodite if compared with that of the next species, *E. victoriensis* (Pl. XX. fig. 33).

There are no sperm-receptacles with conspicuous openings in the female.

The eyes are rather larger than in *E. fossor*, and the rostrum is longer and ends in an upwardly directed spine. The contour of the forehead (Pl. XVIII. fig. 26) is much less steep than in *E. fossor* (Pl. XIV. fig. 12).

Thorax, abdomen, and tail-fan much as in *E. fossor*.

Length. Specimen figured from tip of rostrum to end of telson, 60 mm.

Localities:—

1. Several specimens from Warburton, Victoria, 13. xi. 05. One specimen with equal-sized claws figured (fig. 23). Four other specimens similar to this one in the matter of shape of claws, though varying greatly in hairiness. One specimen with one very large and stout chela (fig. 24), not hairy; the other chela of this specimen was unfortunately missing.

2. Two specimens from the Upper Yarra, collected by Mr. Williams in 1869 and 1871. In both the chelæ are equal in size and rather slenderly built.

3. Two specimens from the top of Black Spur, Fernshaw, 1880. In both these specimens the right chela is much larger and more massive than the left, which is elongated and narrow. One other small specimen from Fernshaw has the chelæ similar and equal. Another specimen, simply labelled "Victoria," resembles the last-named.

4. One very large specimen from Healsville, Victoria, 5. vi. 82, has the right chela enlarged and massive, the left chela narrow and elongated.

ENGÆUS VICTORIENSIS, sp. n. (Pls. XVIII.-XX. figs. 27-29, 32 & 33.)

The penultimate pleurobranch is more than double the size of the last pleurobranch, the latter being greatly reduced in size.

The exopodite of the third maxillipede is absent.

The antennal scale ends in a well-developed terminal spine and an inner lobe which is not markedly produced.

First antenna (Pl. XVIII. fig. 28) as in *E. fossor*.

The chelæ resemble those of *E. affinis*, save that when one is enlarged the propodite is not so broad and short, but is rather more elongate in shape than in *E. affinis*. There is, as usual, great variability in size, shape, and symmetry of the claws.

The rostrum resembles essentially that of *E. affinis*, but the contour of the forehead (fig. 27) is a little steeper.

The abdomen of both sexes is rather broader than in *E. affinis*.

Length of specimen figured from tip of rostrum to end of telson, 65 mm.

Localities:—

1. One specimen from the top of the Dandenong Ranges, Victoria (*Kershaw*, ii. 72) (Pl. XIX. fig. 29). Left chela enlarged, right slender.
2. One specimen, S. Gippsland, July 1891, exactly similar to above.
3. One specimen, Boxhill, near Melbourne, has right chela enlarged, left slender.
4. Two small specimens, Emerald, Victoria (*E. Jarvis*, viii. 04). Left chela enlarged, right slender, the other with chelæ subequal.
5. Several (small) from Fern Tree Gully, Victoria. Some with right chela enlarged, some with left.
6. One specimen from Croydon, Victoria (*F. P. Spry*, 1. xi. 04). Right chela enlarged.
7. One specimen from Ringwood, Victoria (*E. H. Hennell*, xi. 90). Left chela enlarged.
8. Several specimens, simply labelled "Victoria." Some with right chela, some with left enlarged; a few with chelæ subequal or equal.
9. One very large specimen from the Launching Place, Victoria (*J. Coghill*, 15. i. 07), with left chela enlarged.

Remarks on the above two species, E. affinis and victoriensis.

These two species, which are very widely distributed in Victoria, are clearly distinguishable from the Tasmanian *E. fossor* by a number of characters, and from the succeeding species, *E. phyllocercus*, by the remarkable shape of the uropods in the latter form. But the characters distinguishing *E. affinis* and *victoriensis* are very slight, and it may be possible at some time to merge them together in one species, *victoriensis*. The only really satisfactory character is the size of the last pleurobranch, which is reduced in *victoriensis* and well developed in *affinis*. The only other character which is of use in separating the two forms is the shape of the enlarged chela, which is shorter and broader in *affinis* than in *victoriensis*; but since the enlarged chela is not always developed, this character is an unsatisfactory one.

ENGÆUS PHYLLOCERCUS, sp. n. (Pls. XIX. & XXI. figs. 30, 31, & 36.)

All the pleurobranchs are of approximately equal size, the last one not being reduced.

The exopodite of the third maxillipede is reduced, but is clearly to be seen, and it is tipped with several plumose hairs (Pl. XXI. fig. 36).

The antennal scale ends in a spine which is less elongated than in the preceding two species.

The first antenna is similar to that of preceding species.

The great chela has both the upper and lower borders of the

propodite serrated. There is a single row of tubercles on the upper and inner border of the carpopodite, and a row of tubercles on the upper border of the meropodite. The shape of the chelæ is somewhat elongated, and one is generally enlarged, the other remaining slender.

The rostrum ends in a rather blunt upcurved spine, which is shorter and blunter than in the two preceding species.

The uropods exhibit a peculiar and highly characteristic modification, in that both endopodite and exopodite are produced distally into pointed apices, giving the tail-fan a leaf-like appearance (Pl. XIX. fig. 31).

Length of specimen figured from tip of rostrum to end of telson, 59 mm.

Localities. Narracan River, Thorpdale, Trafalgar. All these are Gippsland localities to which the species appears to be confined.

Variety. The rudimentary exopodite of third maxillipede varies in size in the different specimens, and in one specimen from a small stream near Thorpdale, Gippsland, collected by Mr. Kershaw in March 1890, the exopodite is reduced to a small papilla.

ENGÆUS HEMICIRRATULUS, sp. n. (Pls. XX.-XXII. figs. 34, 35, 37, 38.)

The posterior pleurobranch is entirely absent.

The exopodite of the third maxillipede is absent.

The antennal scale ends in a prolonged curved and blunt spine, and the inner lobe is small (Pl. XXII. fig. 37).

The first antenna has only one flagellum, the inner flagellum being entirely absent (fig. 38).

The upper and under and posterior borders of the propodite of the chela are studded with marked tubercles, as are also the borders of the carpopodite, so that the chela as a whole has a more tubercular appearance than in any of the other species. One chela is generally more stoutly developed than the other, sometimes on the right side and sometimes on the left. The pencils of hairs on the chelæ are more conspicuous than in preceding species.

There are no sperm-receptacles with conspicuous openings in the female.

The eyes are not markedly reduced. The rostrum has a conspicuous rounded hump at its base, but is flat and keelless distally and ends in a blunt spine. Just proximal to the point of the spine is a conspicuous bunch of hairs. The contour of the forehead is not at all steep.

The thorax is vaulted and deep as in the preceding species; the abdomen is reduced and hairy. The tail-fan is normal in shape, but the pencils of hairs upon it are particularly conspicuous.

Colour. (From coloured figures by McCoy.) Carapace dull purple. Chelæ reddish. Legs and abdomen brownish grey.

Length 51 mm.

Localities :—

1. Three female specimens and one male from a hill near Thorpdale, Gippsland (*W. Kershaw*, iii. 90), with left chela larger than right. These range in size from 70 mm. to 31 mm. Four small specimens, ranging in size from 30 mm. to 18 mm., had the chelæ equal or subequal.

2. Several specimens from Warragul, Gippsland. A large female, 80 mm. in length, with right chela enlarged, 3. ix. 92; and several specimens, some with right chela enlarged, others with left, and some with equal chelæ (*Prof. B. Spencer*).

3. A large male, measuring 65 mm., with equal chelæ, from Moyarra, near Oultrim, S. Gippsland (*Kitson*, 1905).

4. A male, measuring 50 mm., with right chela enlarged, from Kongwak, near Jumbanna, S. Gippsland (*Kitson*, 1902).

Remarks. This species was partly described and figured by McCoy in MS. as *Hemicirratulus hystrix*. Since it does not fit in with the scheme of this memoir to place this species in a separate genus, we have retained McCoy's MS. generic name, *hemicirratulus*, as the specific name. The species is a constant and easily recognised one; the chelæ, as usual, are variable in development, and the rostrum differs somewhat in the different specimens. In the specimens from S. Gippsland the rounded hump at the base of the rostrum extends rather further along the rostrum than in the specimens from other parts of Gippsland.

ENGÆUS CUNICULARIUS Erichson, (Pls. XXII.—XXV. figs. 39–47.)

Erichson, Archiv f. Naturg. vol. xii. p. 102 (1846); Von Martens, Monatsber. Akad. Wiss. Berlin, 1868, p. 619; Haswell, Cat. Australian Mus., Stalk- and Sessile-eyed Crustacea, p. 179 (1882).

The posterior pleurobranch is present, and is the largest of all four pleurobranchs, which increase in size from before backwards.

The third maxillipede has a well-developed exopodite (fig. 46).

The scale of the second antenna has a short terminal spine and a well-developed inner lobe (fig. 47).

The two flagella of the first antenna are nearly equal in length, the outer flagellum being slightly longer than the inner.

The upper or inner border of the propodite of the chela has a row of five tubercles; the lower or outer border is smooth. There is a row of feeble serrations on the inner border of the carpopodite and on the upper border of the meropodite, but the chela on the whole is very feebly tuberculated and comparatively free from hairs. There is, however, great variability in the chelæ.

There are no conspicuous sperm-receptacles in the female.

The eyes are large and comparatively unreduced.

The rostrum is straight, well-developed, and ends in a blunt spine. There are two highly-developed tumid keels on its sides, which are continued a little way back on to the carapace.

The thorax is less highly vaulted and more normal in shape than in the foregoing species.

The abdomen is very large and unreduced; the telson is broad and the tail-fan rounded, well developed, and normal in shape. The abdomen and tail-fan are not at all conspicuously hairy.

The colour varies from reddish brown to olivaceous grey, while parts of the chela and thorax may be picked out in bright blue and red.

Localities:—

1. Tasmania. In one specimen, a male, both chelæ are large and equal in size and shape. There is a peculiar compound tooth on each jaw of the pincer (Pl. XXII. fig. 39). This specimen comes from Glenore, near Hageley, Tasmania (*Bartholomew*, 29. v. 89). In one male specimen from Launceston, Tasmania (*Bartholomew*, 1890), the left chela is enlarged and resembles that of the above specimen; the right chela is toothless, small, and slender. A similar specimen, but a female, comes from Mundan Farm, Longford, Tasmania (*Bartholomew*, 1889).

2. Warragul, Gippsland. Three male specimens (*Kershaw*, 1887, 1888), two with left chela enlarged, one with right. There is a prominent peg-like tooth on the dactylopodite part of the enlarged pincer; the compound tooth on fixed jaw of pincer is reduced (Pls. XXII., XXIII. figs. 41 & 42).

3. Near Lake's Entrance, Gippsland. One female specimen (*Kershaw*, 1887) with two similar chelæ without teeth (fig. 40). This type of chela is intermediate in character between the large and small chela of the specimens from Warragul (figs. 41 & 42).

4. Derby River, Wilson's Promontory (*Kershaw*, 1905). Three specimens, all with similar and equal chelæ. Teeth are present in the pincer, but are reduced in size. The chelæ are rather elongated in shape.

A note appended to these specimens states that they build conical mud towers, about 8 to 10 inches high, on the flats.

5. From banks of Fraser Creek, Oberon Bay, Wilson's Promontory (*Kershaw*, 1905). Similar to the last mentioned, but pincer tends to be less elongated.

6. Male specimen from Croydon, Victoria (*Fulton*, 1907), with left chela enlarged. Interior of pincer is hairy and without any enlarged teeth.

7. Female specimen from Fern Tree Gully, with left chela enlarged and small teeth in pincer.

8. Numerous specimens from Croydon, Victoria, and unnamed Victorian localities, characterised by the presence of a thick pad of fine downy hairs on the inner surface of the chela (Pl. XXV. fig. 45), and also a thick covering of downy hairs on the third maxillipedes. This constant character is possibly of specific value, and it might be advisable to separate these forms as a distinct species; but they do not apparently show any other differences to distinguish them from the typical *E. cunicularius*. It is a remarkable fact that an exactly similar downy pad occurs in some species of *Chæraps*.

Engæus fultoni, sp. n.

This species agrees with *E. cunicularius* in all its characters, save that the exopodite of the third maxillipede, instead of being large and normally developed, is reduced to a small papilla as in *E. phyllocercus*. The teeth in the pincer of the chela are not fused to form a compound tooth, but there are several, about three, small teeth on the lower jaw of the pincer and two on the upper. The lower border of the propodite of the chela has a distinct serrated keel.

Localities :—

1. Two specimens from Fern Tree Gully, Victoria, one being a female measuring 53 mm., with both chelæ large and equally developed; the other a small female measuring 35 mm., with the left chela enlarged and the right slender.
2. One male from Cape Otway Forest, Victoria (collected by W. Fulton, 28. v. 07), with both chelæ similar, fairly stoutly built, and markedly hairy.

EXPLANATION OF THE PLATES.

PLATE XII.

- Fig. 1. Semidiagrammatic cross-section of podobranch of *Astacopsis*. *al.* = ala.
Only a few of the gill-filaments are shown.
2. Terminal hook from gill-filament on ala, taken from the podobranch of *Astacopsis*.
 3. Ends of hooked setæ from podobranch of *Astacopsis*.
 4. Semidiagrammatic section of podobranch of chela in *Parachæraps*.
 5. Terminal hook from gill-filament of *Parachæraps*.
 6. End of hooked seta from podobranch of *Parachæraps*.

PLATE XIII.

- Fig. 7. Podobranch of great chela from *Engæus cunicularius*. $\times 4\frac{1}{2}$.
8. Semidiagrammatic transverse section of do. $\times 12$. *al.* = ala.
9. Tips of hooked gill-filaments from ala of do. $\times 250$.
10. Tips of hooked setæ from podobranch of do. $\times 250$.

PLATE XIV.

- Fig. 11. *Engæus fossor*. From dorsal surface. $\times 1\frac{1}{2}$.
12. " " Side view, with limbs removed. $\times 1\frac{1}{2}$.

PLATE XV.

- Fig. 13. *Engæus fossor*. Sperm-receptacles on penultimate segment of thorax in the female. $\times 2\frac{1}{2}$.
14. " " Basal portion of right antenna from above. $\times 6\frac{1}{2}$.
 15. " " Scale of antenna. $\times 12$.
 16. " " Left mandible from above. $\times 6\frac{1}{2}$.
 17. " " Do. from below.

PLATE XVI.

- Fig. 18. *Engæus fossor*. First maxilla (left) from above. $\times 6\frac{1}{2}$.
19. " " End of exopodite of first maxilla. $\times 65$.
20. " " Second maxilla (left) from above. $\times 6\frac{1}{2}$.
21. " " Second maxillipede (left) from below. $\times 6\frac{1}{2}$.

PLATE XVII.

- Fig. 22. *Engaeus fossor*. Basal portion of third maxillipede (left) from above. $\times 6\frac{1}{2}$.
 23. " *affinis*, ♀. Dorsal view. $\times 1\frac{1}{2}$.
 24. " " Great chela. $\times 2\frac{1}{4}$.
 25. " " Scale of antenna (left). $\times 6\frac{1}{2}$.

PLATE XVIII.

- Fig. 26. *Engaeus affinis*. Contour of forehead. $\times 2\frac{1}{4}$.
 27. " *victoriensis*. Contour of forehead. $\times 2\frac{1}{4}$.
 28. " " First antenna (left). $\times 6\frac{1}{2}$.

PLATE XIX.

- Fig. 29. *Engaeus victoriensis*, ♀. Dorsal view. $\times 1\frac{1}{2}$.
 30. " *phyllocercus*, ♀. Dorsal view. $\times 1\frac{1}{2}$.
 31. " " Telson and uropods. $\times 2$.

PLATE XX.

- Fig. 32. *Engaeus victoriensis*. Telson and uropods. $\times 2$.
 33. " Great chela. $\times 2\frac{1}{3}$.
 34. " *hemicirratulus*. " Face." "

PLATE XXI.

- Fig. 35. *Engaeus hemicirratulus*. Dorsal view. $\times 1\frac{1}{4}$.
 36. " *phyllocercus*. Third maxillipede (left) from below.

PLATE XXII.

- Fig. 37. *Engaeus hemicirratulus*. Base of right first antenna from below. $\times 6\frac{1}{2}$.
 38. " First antenna. $\times 6\frac{1}{2}$.
 39. " *cunicularius*. Chela of male from Glenore, near Hageley, Tasmania (fig. 43). $\times 2\frac{1}{4}$.
 40. " " Right chela of female found near Lake's Entrance, Gippsland. $\times 2$.
 41. " " Right chela of male specimen from Warragul, Gippsland. $\times 2$.

PLATE XXIII.

- Fig. 42. *Engaeus cunicularius*. Left chela of male specimen from Warragul, Gippsland. Companion to fig. 41.
 43. " " ♂. From Glenore, near Hageley, Tasmania. $\times 1\frac{1}{2}$.

PLATE XXIV.

- Fig. 44. *Engaeus cunicularius*, ♂. From Warragul, Gippsland. $\times 1\frac{1}{2}$.

PLATE XXV.

- Fig. 45. *Engaeus cunicularius*. Left chela of specimen from Croydon, Victoria.
 46. " " Third maxillipede (right) from above. $\times 4\frac{1}{2}$.
 47. " " Scale of left antenna. $\times 6\frac{1}{2}$.

10. On some Points in the Anatomy of the Mouth-parts
of the Mallophaga. By BRUCE F. CUMMINGS *.

[Received October 17, 1912: Read November 26, 1912.]

(Text-figures 24-32.)

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The Mallophaga are for the most part such small parasites that the dissection of the mandibulate mouth is often a matter of considerable difficulty. It seems scarcely surprising, therefore, that a good deal of misunderstanding has arisen in regard to the mouth-parts, and in the literature which deals with this subject a variety of opinion will be found on such questions as the palpi, the œsophageal sclerite, and so on.

The Palpi of the Ischnocera.

In a paper in the P.Z.S. 1909 (1), appear figures and descriptions of the Ischnoceran species *Goniodes tetraonis* Denny, from the Grouse, in which a pair of very minute one-jointed appendages is shown to exist on the labium below the paraglossæ. In *G. falcicornis* N., I can find no trace of these minute appendages, which perhaps represent the palpi of the second maxillæ. In the same place, the second maxillæ of *G. tetraonis* are described as rounded with certain setae or hairs, whence it appears that in this species they are less degenerate than in the other Ischnocera so far examined, where the second maxillæ are usually obsolete, flat lobes without palpi, thinly chitinized (or not chitinized at all), and situated within the mouth-cavity behind the mandibles. From the figures of both *G. tetraonis* and another *Nirmus cameratus* N. they are omitted, and instead, the paraglossæ of the labium are labelled first maxillæ and the minute appendages second maxillæ.

The Palpi of the Amblycera.

The other suborder, the Amblycera, is distinguished by the presence of a pair of jointed palpi absent from the Ischnocera. The view of Nitzsch, who first considered them in 1818 (2), may at length be considered as sound, namely, that they belong to the first maxillæ and not to the labium. Grosse (1885) (3) assigned

* Communicated by the SECRETARY and published by permission of the Trustees of the British Museum.

them to the labium. Snodgrass (1896) (4) followed suit, but in 1905 (5) retracted in favour of Nitzsch, as the result of examining preparations of *Ancistrona gigas* P. and *Læmobotrium gypsis* Kell., in which the stipes of the palpus was seen to be separate from the labium. C. O. Waterhouse (1904) (6) had already illustrated the fact that in *L. titan* P. the palpus was connected with the maxilla by a delicate band of connective chitin. I have discovered similar slips not only in *L. titan*, but in *Ancistrona procellarice* Westwood (text-fig. 25, p. 132) and in *Nitzschia pulicaris* N.

The œsophageal Sclerite and Lingual Glands.

These structures are unique in the comparative anatomy of the insect mouth. They occur in their typical form in the Ischnocera. In the other suborder it is customary to say that they are either modified or absent, but, as I show below, they are really present in all the Amblycera with the possible exception of *Latumcephalum*, which was not available for examination. The œsophageal sclerite and glands in the Mallophaga were first discovered by Snodgrass (4). They are unusually difficult of dissection in the Amblycera on account of their delicacy and minuteness and their position below the œsophagus, having regard to the flatness of the head in the Mallophaga as a whole.

The sclerite in the Ischnocera is of a densely chitinous character, usually quite visible through the integument lying in the lower wall of the œsophagus behind the labium. There are two anterior cornua and sometimes a posterior pair, but these are absent in *L. ferox* G. (text-fig. 24, p. 131). Lying longitudinally in the dorsal wall of the œsophagus immediately above the sclerite, I find in *Goniodes falcicornis* and in *Lipeurus ferox* a long, narrow chitinous splint. Towards this, the posterior cornua in *G. falcicornis* curl up the sides of the œsophagus.

The lingual glands are hard, flat, oval pieces of chitin in which no glandular structure can be detected, though they still await histological examination. In *L. ferox* and *G. falcicornis*, if not in most other Ischnocera, the anterior ends of the two glands are encompassed by a small compound plate of chitin (text-fig. 24, E), narrowing towards the edge of the labium. A curious duct, cross-barred like a trachea, arises from the sclerite and runs forward, where it bifurcates, one ramus (or "bronchus") entering each of the glands. My own dissections lead me to agree with Mjöberg (1910) (7) and Grosse (3), who regard the "glands" as chitinous and as part of the sclerite, the whole to be regarded as a compound hypopharynx*. Normally the hypopharynx lies

* A central canal is almost certainly present in the ducts of some, but its meaning remains problematical, unless we suppose that a kind of chitinous sclerosis has overtaken real glands and ducts, until finally, in such genera as *Ancistrona* and *Trinoton* (text-figs. 26 & 29), the original structures have become obliterated and replaced by chitin.

immediately above the labium in front of the mouth and not below the œsophagus, and on this account Snodgrass gives the term hypopharynx only to certain setose lobes he found in *Læmbobothrium gypsis* which actually overlie the labium. A similar arrangement of lobes is seen in *L. titan*, where, as the anterior area of the hypopharynx, they are in close relation with the sclerite and "glands"—the elaborate posterior area. The Ischnocera possess an anterior area—the true hypopharynx of Snodgrass—in the small encompassing plate mentioned above, which is much reduced in correspondence with the fact that in the Ischnocera the whole labium has been shifted backwards so as to leave the large mandibles a free field. In some genera of the Amblycera such as *Boopia* or *Heterodoxus* the anterior area, in which, as in *Læmbobothrium*, the "ducts" are incorporated, is so large as to extend not only as far as above the labium but even beyond it as two lobes protruding from the mouth (cf. Mjöberg (7), p. 22). The two areas run into each other without any dividing line.

Varieties of Sclerite and Glands.

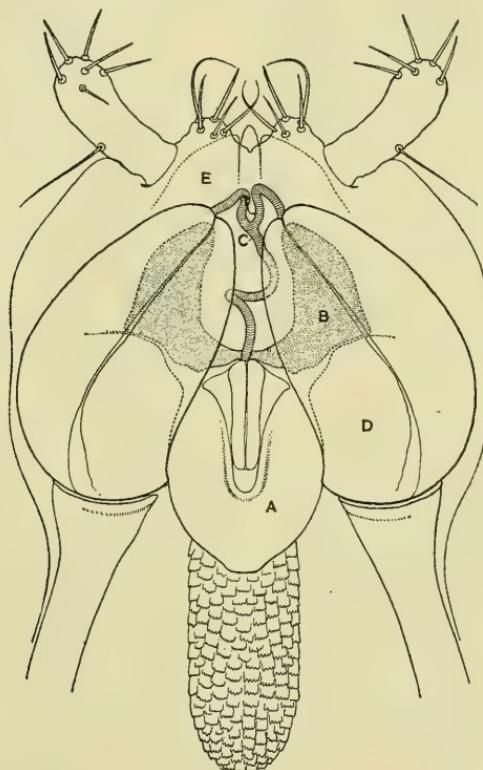
I shall now discuss the various forms the hypopharynx assumes in the different genera of the Amblycera. Modification begins with *Læmbobothrium* (see diagram, text-fig. 25, p. 132), in which the sclerite is elongated and the anterior cornua very long, extending almost up to the bifurcation of the "ducts." The "glands" are less developed. The posterior cornua are present. In *Gyropus* the main "nucleus" of the sclerite has disappeared, the anterior cornua are fused at the base, and the posterior cornua are longer and the "glands" very much reduced. In *Trinoton*, the "glands" as such have quite disappeared, but may here be represented by the lateral pieces, the bifurcating sclerite being the broadened "duct."* The anterior cornua are entirely fused together. In *Ancistrona procellariae* the anterior cornua are quite distinct but adpressed closely against the broad rami; each of the rami bears in front a rounded plate with a strongly serrate edge corresponding with the anterior area of the hypopharynx. The diagram is intended to show the probable evolution of the structure in the Ischnocera and Amblycera.

The presence of œsophageal sclerite and "glands" in the Psocidæ as well as in the Mallophaga points to the antiquity of the structures. Several features in the anatomy of the Psocidæ

* In *Dochophorus sphenophorus* (text-fig. 27), an Ischnoceran, the ducts are so minute and delicate as to suggest atrophy. In front, they are accompanied and supported by a forked piece of chitin, and in other species and genera the duct is clearly seen to be accompanied along its course by chitin, so that in those forms where the ducts *qua* ducts are absent their former course along the bottom of the pharynx may be traced in the track of persisting chitin which they leave behind. It is this forked piece of chitin, rather than the duct itself perhaps, which is homologous with the bifurcating sclerite in *Trinoton* (text-fig. 29, B) and other genera.

and Mallophaga indicate their affinity, and a plausible theory has been suggested that the latter are Psocids which have undertaken a parasitic existence. In any case the "glands" and sclerite must be regarded as part either of their Psocid or pre-Psocid inheritance, so that the typical oesophageal sclerite and "glands" of the Ischnocera are older than the modifications

Text-fig. 24.

Hypopharynx and lingual glands of *Lipeurus ferox*, $\times 186$.

A, oesophageal sclerite; B, anterior cornu; C, duct; D, gland;
E, anterior compound plate.

described in the Amblycera, in spite of the fact that the Amblycera by the possession of jointed palpi, by the form of the alimentary canal, by the position of the mouth-parts which have not shifted backwards, and in several other respects appear to be the less specialised of the two suborders.

Text-fig. 25.

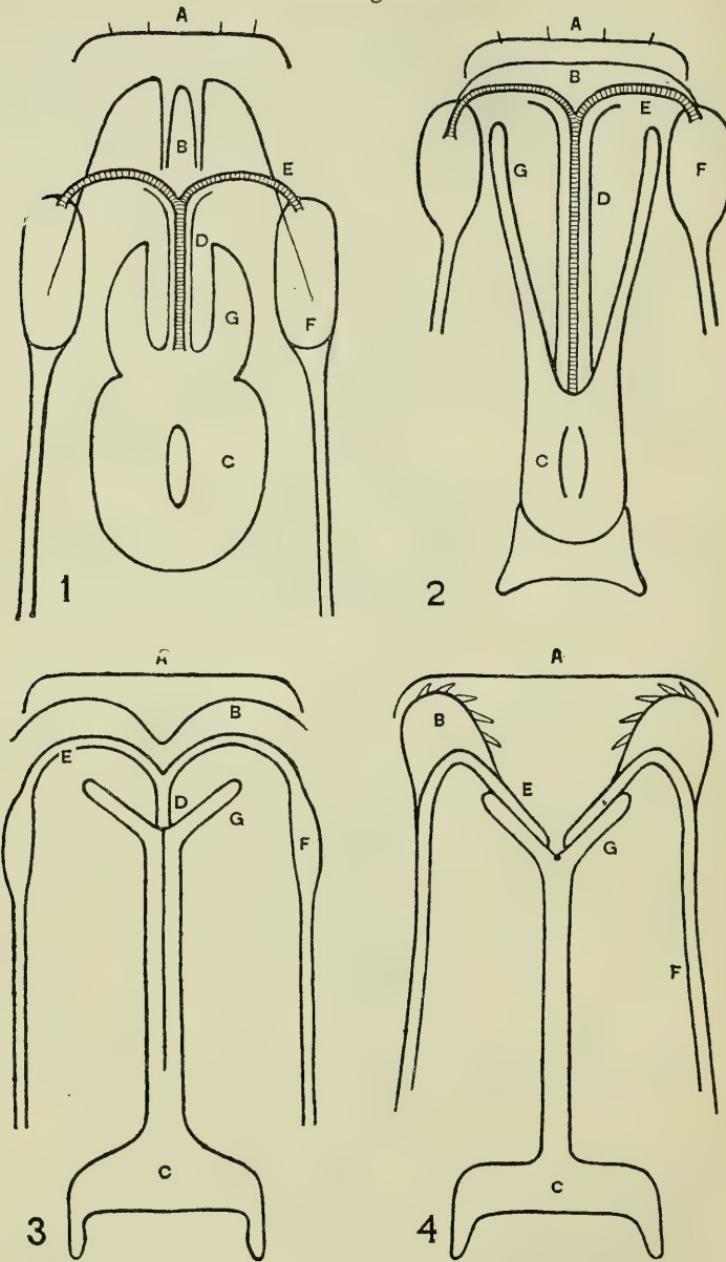


DIAGRAM to illustrate the evolution of the hypopharynx.

(1) *Lipeurus*. (2) *Laemobothrium*. (3) Hypothetical. (4) *Ancistrone*.
 A, edge of labium; B, anterior compound plate; C, osophageal sclerite; D, "duct";
 E, rami; F, "glands" or lateral pieces; G, anterior cornu.

Distribution of the Sclerite and "Glands."

A revised list of the distribution of the sclerite and "glands" in the Mallophaga must now stand:—

Genera with sclerite and glands more or less typically developed.	Genera with sclerite and glands modified.	Genera with sclerite and glands absent.	Genera with sclerite and glands present or absent.
ISCHNOCERA. Goniodes, Goniocotes, Onchophorus, Trichodectes, Eutrichophilus, Eurymetopus, Giebelia, *Ornicholax, *Kelloggia.	AMBLYCERA. Boopis, Nitzschia, Heterodoxus, Trinoton, †Trimenopon, Ancistrona, Latumcephalum? Gliricola?	ISCHNOCERA. Ornithobius? Akidoproctus? AMBLYCERA. Eureum?	Dochophorus? Lipeurus? Menopon? Nirmus?
AMBLYCERA. Colpocephalum, Læmbobothrium, Physostomum, Gyropus.	Dochophorus sphenophorus, Tropothalmus, Pseudomenopon.		

All the species examined of *Nirmus*, *Menopon*, *Lipeurus*, and *Dochophorus* in the collection of the British Museum possess sclerite and glands. Snodgrass records them as absent from *N. signatus*, *L. picturatus*, and *L. longipilus*, *D. icterodes*, and the following species of *Menopon*:—*distinctum*, *malleus*, *persignatum*, *præcursor*, *rediculorum*, *robustum*, *titan*, and *tridens*. The sclerite and glands are certainly present in *titan* and in *tridens*, though they are considerably modified and require careful dissection. They are described below. From a summary inspection of *Dochophorus sphenophorus* N. the structures appeared to be absent, but here again on dissection I found them present in a modified form (text-fig. 27, p. 135).

Descriptions of Special Cases.

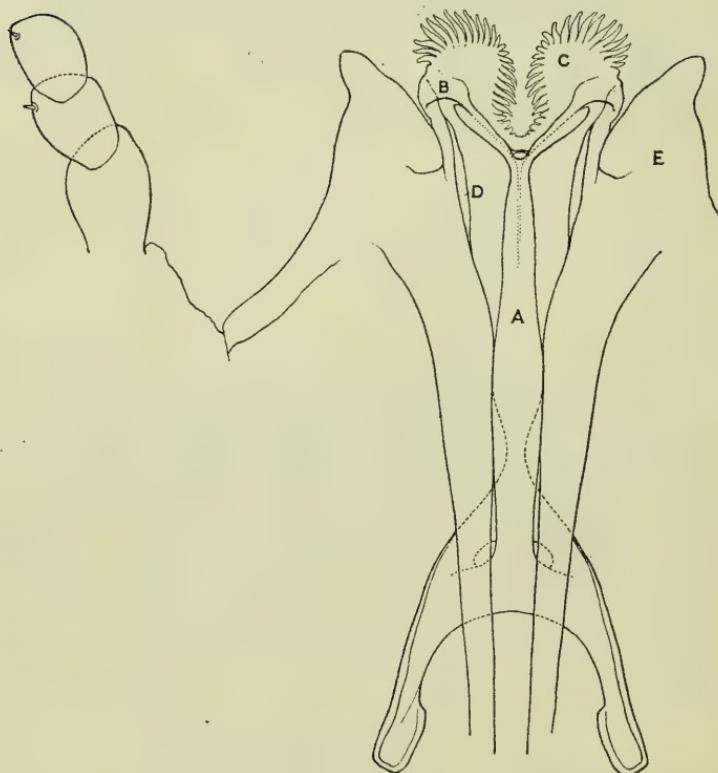
Ancistrona procellariae Westwood (from *Procellaria capensis*).—The hypopharynx was incorrectly described and figured by Westwood (1874) (8) as a rod bifurcating in front. The lateral pieces (text-fig. 26, D) were omitted. In all probability the

* The typical sclerite and glands where they occur are plainly visible through the integument, and, according to figures of these two genera, are present in them. When modified, the sclerite and glands cannot be discovered without dissection, and this, perhaps, accounts for the third column being so long in the list given by Snodgrass.

† Gen. nov. about to be described in the Bulletin for Entomological Research.

lateral pieces became detached while the preparation was being made, as they are very delicately connected. Snodgrass in his account of *A. gigas*, a closely allied species, does not mention any lateral pieces, figures the hypopharynx as a bifurcated rod and calls it the epipharynx. But the presence of "maxillary forks" is recorded in *A. gigas*, and these I have been unable to find in *A. procellariae*. If they are absent, it might very well be that Snodgrass has mistaken the detached lateral pieces for maxillary forks. They are alike in shape. The maxillæ are attached to the lateral pieces (text-fig. 26, E).

Text-fig. 26.

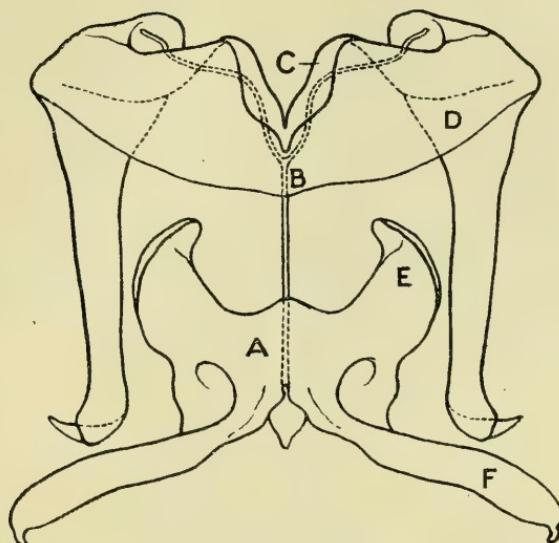


Hypopharynx of *Ancistrona procellariae*, $\times 202$.

A, oesophageal sclerite; B, ramus; C, anterior hypopharyngeal plate;
D, lateral piece; E, 1st maxilla.

Dochophorus sphenophorus N. (from *Platalea leucorodia*).—This species presents an interesting transition between the glands and sclerite typical of the Ischnocera and the conditions found in the

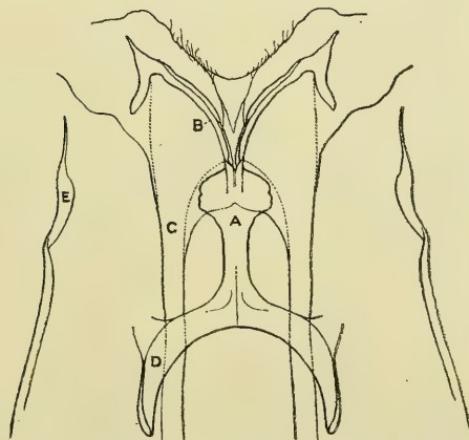
Text-fig. 27.



Hypopharynx of *Dechophorus sphenophorus*, $\times 360$.

A, œsophageal sclerite; B, duct; C, bifid sclerite; D, lateral piece;
E, anterior cornu; F, posterior cornu.

Text-fig. 28.



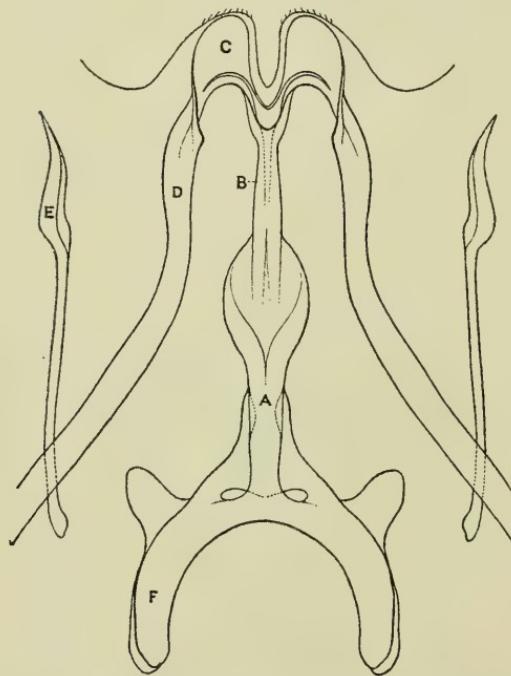
Hypopharynx of *Tropothalmus titan*, $\times 204$.

A, œsophageal sclerite; B, the two rami; C, lateral piece;
D, posterior cornu; E, maxillary fork.

Amblyceran genera *Trinoton*, *Ancistrona*, etc. The glands are almost completely transformed into lateral pieces (text-fig. 27, D), but may still be represented by an indistinct circular impression on each lateral piece in front where it is joined by the delicate ducts which are supported by a forked piece of chitin, homologous probably with the forked piece in *Trinoton* and others. The œsophageal sclerite is of a peculiar form, quite different from that of other *Dochophori* and *Ischnocera*. It is not visible without dissection.

Tetrophtalmus titan Piag. (formerly *M. titan*) [from the Pelican].—The rami of the broad "duct" bifurcate far forward at the front margin of the labium. No traces of the "glands" (text-fig. 28, p. 135). In *Pseudomenopon tridens* (formerly *M. tridens*), the hypopharynx is very similar, but the lateral pieces are narrow in front where they run into the rami.

Text-fig. 29.



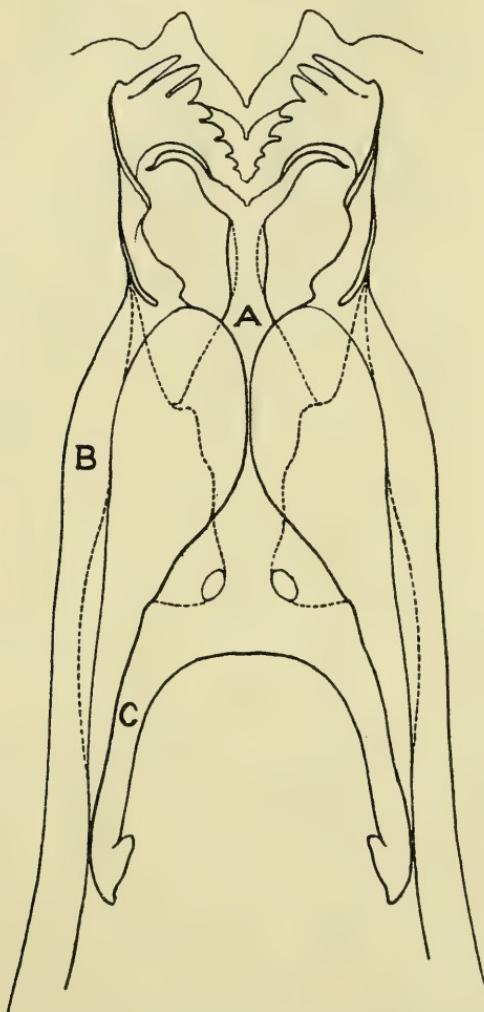
Hypopharynx of *Trinoton luridum*, $\times 245$.

A, œsophageal sclerite; B, fused rami; C, anterior lobes of hypopharynx; D, lateral piece; E, maxillary fork; F, posterior cornu.

Trinoton luridum N. (from the Duck).—The anterior cornua have disappeared—probably fused in the central rod, which is

unusually broad here. The anterior area of the hypopharynx contiguous with the curving rami of the "duct" consists of two lobes with a few minute hairs (text-fig. 29).

Text-fig. 30.

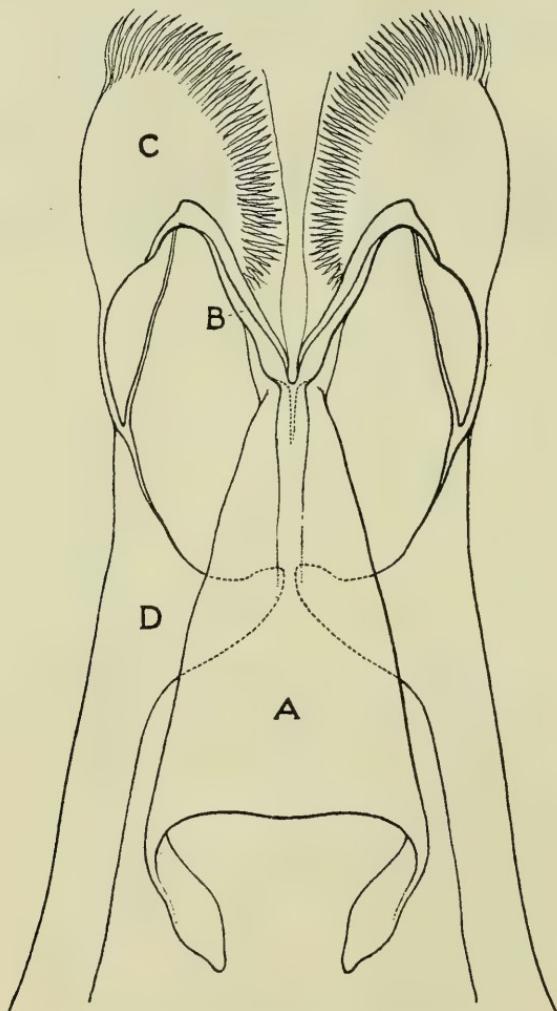
Hypopharynx of *Nitzschia pulicaris*, $\times 570$.

A, oesophageal sclerite; B, lateral piece; C, posterior cornu.

Nitzschia pulicaris N. (from the Swift).—The lateral pieces are broad and thinly chitinized. The "ducts" are broad, and there are teeth on the anterior area (text-fig. 30).

Heterodoxus macropus Le Souëf (from the Wallaby).—Numerous setæ on the anterior area. The lateral pieces exhibit no traces of glands. There is a projection on the inner side of each lateral

Text-fig. 31.

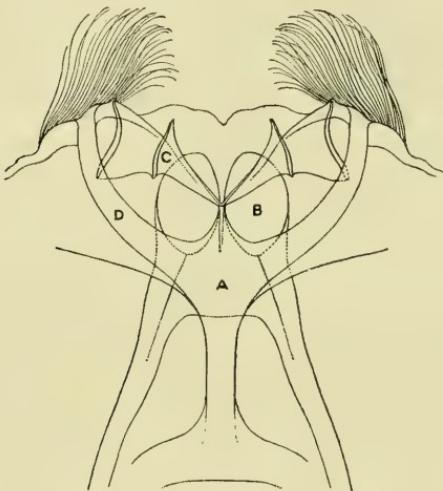
Hypopharynx of *Heterodoxus macropus*, $\times 500$.

A, oesophageal sclerite; B, rami; C, anterior lobe of hypopharynx;
D, lateral piece.

piece which almost meets its fellow from the other side (text-fig. 31). *Boopia* is similar, with an elegantly curved hypopharynx thickly clothed in front with setæ.

Physostomum sp.? *mystax*.—The “glands” are present but appear to underlie the ducts, with which I cannot find their point of attachment. Only one rather poor specimen formed my available material for dissection in this species. The anterior cornua are very long and curl round in front (text-fig. 32).

Text-fig. 32.

*Physostomum* sp., $\times 219$.

A, cesophageal sclerite; B, glands; C, rami; D, anterior cornu.

The Maxillary Forks.

These problematic “forks” are delicate chitinous rods unconnected with the rest of the mouth-parts, but lying within the mouth, one on either side of the hypopharynx. They have been recorded from *A. gigas* P., *Goniodes dissimilis* N., *Læmbobothrium gypsis* Kell. I find them present in *Tetraphthalmus titan* P. (text-fig. 28, E), *Læm. titan* P., *Trinoton luridum* N. (text-fig. 29, F). On account of their fragile nature they may easily be overlooked, and therefore perhaps exist in many other species. It is tempting to look upon these “forks” as the maxillulae or super-linguae of the hypopharyngeal or fifth segment of the insect head. A third pair of maxillæ are present and well developed in many Apterygota, and recently Prof. G. H. Carpenter and Miss Mabel MacDowell have made a further contribution to the question of the serial homologies of the insect head by a paper (1912) (10) on the mouth-parts of certain beetle larvae, where the maxillulae are represented, it is suggested, by the side pieces of the hypopharynx. This question in the Mallophaga is worth investigation. An alternative suggestion is that the maxillary forks are the inner

lobes of the first maxillæ, the maxillulæ being the glands and rami (or the lateral pieces as the case may be). This view has been actually put forward on behalf of the "glands" by Dr. Günther Enderlein (1903) (11).

Conclusion.

Dissections of the head, particularly in those species of the large genus *Menopon* where the hypopharynx has been reported to be absent, ought to yield useful data for systematic work. It is curious that the case of *Dochophorus sphenophorus* from which, at first, the glands and sclerite appeared to be absent, should on careful examination be found to present a hypopharynx constituting so abrupt a deviation from the normal form in the Ischnocera, because this species is a typical *Dochophorus* differing in external character but little from the group to which it belongs. Now that schemes of classification, instead of being merely arbitrary modes of arrangement for the convenience of systematists, are expected to indicate phylogenetic relationships whenever possible, it becomes necessary to include in descriptive work internal as well as external characters. If the hypopharynx were an external character, its peculiar form in *D. sphenophorus* would, with some students of the order, be sufficient reason for instituting a new genus for its reception.

The oesophageal sclerite is probably present in all Mallophaga, and in breaking up many of the unwieldy genera such as *Dochophorus* and *Menopon*, it should prove to be of great assistance. Of the list of species of *Menopon* in which Snodgrass discovered no sclerite present, one, *M. tridens*, has already been separated out as *Pseudomenopon tridens*, and another, *M. titan*, as *Tetrophtalmus titan*. Both these new genera are now found to possess an oesophageal sclerite, though in a modified form. These facts are suggestive.

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Postscriptum.

Dr. W. T. Calman has kindly drawn my attention to a memoir in the ‘Bollettino della Società di Naturalisti in Napoli’ (vol. xxiv. ser. ii. vol. iv. anno xxiv.), published in 1911, and entitled “Contributo allo Studio dei Mallofagi, Observazione sul *Menopon pallidum*.” This paper unfortunately arrived in this country too late for consideration. The author, Euclide Armenante, investigates *M. pallidum* and finds that the “glands” and “ducts” are, as I suppose, chitinous. The hypopharynx is not typical in this species, but lends support to the homologies indicated above, and appears to stand somewhere between *Læmbothrium* and such forms as *Trinoton*, *Nitzschia*, etc.

11. Report on the Deaths which occurred in the Zoological Gardens during 1912, together with the Blood-Parasites found during the Year. By H. G. PLIMMER, F.R.S., F.Z.S., Pathologist to the Society.

[Received and Read February 4, 1913.]

On January 1st, 1912, there were 885 mammals, 2180 birds, and 518 reptiles in the Zoological Gardens ; and during the year 506 mammals, 1346 birds, and 648 reptiles were admitted, making a total for the year of 1391 mammals, 3526 birds, and 1166 reptiles.

During 1912, 375 mammals, 817 birds, and 347 reptiles have died : that is, a percentage of 26·9 for mammals, 23·2 for birds, and 29·8 for reptiles.

633 deaths out of the total of 1539 for the year occurred in animals which had not been six months in the Gardens. It has been found that after six months' residence in the Gardens the percentage falls rapidly, so that it is assumed that by that time the new animals have got over their journeys, or have died from any diseases they may have brought with them, or have got quite

used to their new environment. 144 of these 633 were mammals, 317 were birds, and 172 were reptiles; and if these be deducted from the above the percentage appears as 16·6 for mammals, 14·2 for birds, and 15 for reptiles.

The following tables show some of the facts ascertained in outline. Table I. summarizes the actual causes of death in the three groups specified. Under Reptiles are included Amphibia.

TABLE I.—Analysis of the Causes of Death.

Diseases.	Mammals.	Birds.	Reptiles.	Reference to Notes following.
1. Microbic or Parasitic Diseases.				
Tuberculosis	14	79	11	1
Mycosis	12	72	2	2
Pneumonia	45	98	124	3
Septicæmia	2	...	...
Pericarditis	5	1	...	
Stomatitis .....	...	...	4	
Peritonitis	7	...	...
Abscess	1	...	1	
Empyema	1	...	...
Hydatids	4	...	...
Worms	4	...	1	4
Dermatitis (sarcoptic)	1	...	...
2. Diseases of Respiratory Organs.				
Bronchitis	12	...	...
Broncho-pneumonia	30	...	...
Congestion of lungs	14	108	22	
Atelectasis	2	...	...
3. Diseases of the Heart and Vessels.				
Aneurism .....	...	1	...	5
4. Diseases of the Liver.				
Fatty degeneration	1	7	...	
Hepatitis .....	...	14	...	
5. Diseases of the Alimentary Tract.				
Gastritis .....	...	1	...	6
Gastric ulceration	8	...	...
Gastro-enteritis	11	1	3	
Enteritis	38	154	25	{ 7
Intestinal obstruction	1	...	...
6. Diseases of Urinary and Generative Organs.				
Nephritis	89	104	9	8
Cystic kidneys	1	...	...	9
Stone	1	...	...
Inflamed oviduct .....	...	1	...	
Sloughing uterus	1	...	...
7. Various.				
Carcinoma	4	...	...	10
Sarcoma	2	1	2	11
Senile Decay .....	...	1	...	
Injuries discovered post-mortem	5	8	1	

Besides those tabulated above,

59 mammals, 100 birds, 2 reptiles, were killed by order
or by companions,
3 „ 3 „ 94 „ died from malnutrition
or starvation,
6 „ 32 „ 70 „ were too stale for de-
tailed examination,

these completing the total.

In Table I. the classification is made of those diseases which actually caused death. Table II. summarizes the other diseases from which the animals were suffering; and if this Table be taken in conjunction with Table I., a much more accurate estimate of the amount of disease in the Gardens will be arrived at.

TABLE II.—Other Diseases found in the animals tabulated in Table I.

Diseases.	Mammals.	Birds.	Reptiles.	Reference to Notes following.
Tuberculosis	4	6	6	
Mycosis	1	2	...	
Pneumonia	3	10	3	
Pericarditis	4	10	...	
Peritonitis	5	...	...
Pleuritis	1	...	...
Malaria .....	...	37	...	12
Filaria	4	30	1	13
Worms	3	2	...	
Hæmogregarines .....	...	...	32	14
Trypanosomes .....	...	11	...	15
Stomatitis .....	...	...	4	
Abscess	9	...	1	
Coccidiosis	2	...	...
<hr/>				
Bronchitis	8	...	...
Broncho-pneumonia	12	...	...
Congestion of lungs	34	63	10	
(Edema of lungs	1	42	21	
Dilated heart	5	3	...	
Atheroma	7	1	...	
Fatty liver	20	50	11	
Hepatitis .....	...	3	2	
Cirrhosis of liver	2	...	...
Gastritis	1	...	1	
Gastric ulceration	18	...	...
Gastro-enteritis	3	...	4	
Enteritis	34	62	20	
Intussusception	3	1	...	
Intestinal obstruction	2	1	...	
Nephritis	52	44	4	
Cystitis	2	...	...
Inflamed oviduct .....	...	5	...	
Rickets	17	1	...	
Arthritis .....	...	1	...	
Chylous ascites	1	...	...

Table III. shows, in still further detail, the distribution of diseases amongst the various orders of mammals.

TABLE III.—Showing the Distribution of Diseases causing Death amongst the principal Orders of Mammals.

Diseases.	Primates.	Carnivora.	Rodentia.	Ungulata.	Edentata.	Marsupalia.
Tuberculosis	5	6	2	1	..	..
Mycosis	2	..	..	..	..	10
Pneumonia	8	15	10	4	5	3
Septicæmia .....	..	1	..	1	..	..
Abscess .....	..	..	..	1	..	..
Pericarditis	2	1	..	1	..	1
Peritonitis .....	..	5	1	..	..	1
Empyema .....	..	1	..	..	..	..
Dermatitis (sarcoptic) .....	..	..	..	1	..	..
Hydatids	1	..	..	3	..	..
Worms .....	..	2	..	..	1	..
<hr/>						
Bronchitis	6	1	3	1	1	..
Broncho-pneumonia	11	7	1	9	..	2
Congestion of lungs	7	1	6	..	..	..
Atelectasis .....	..	..	..	2	..	..
Fatty degeneration of liver .....	..	..	..	..	..	1
Gastritis .....	..	..	..	1	..	..
Gastro-enteritis	1	7	2	2	..	..
Gastric ulceration	3	1	2	2	..	..
Enteritis	12	11	7	5	3	..
Intestinal obstruction .....	..	..	..	..	..	1
Nephritis	24	31	15	13	2	4
Cystic kidneys .....	..	..	..	1	..	..
Stone .....	..	..	..	1	..	..
Cancer .....	..	..	..	3	..	1
Sarcoma .....	..	2	..	..	..	..

Notes on the foregoing Tables.

- There has been a general decrease in the deaths from tubercle during the past five years, which has been most marked in mammals. In 1908, 59 mammals died from tubercle, last year only 14. The percentage of deaths of the total number of animals is 1 per cent. for mammals, 2·2 for birds, and 1 for reptiles. Of the 14 mammals, 9 had not been six months in the Gardens; and 9 were pet animals which had been presented, 1 shared burrows in the squirrel's enclosure with the rats (which we know are infected), 1 had been in captivity in the East for some months before reaching London, and 1 was a tame animal which had been reared by hand. So that only 2 of the old mammal inhabitants died last year from tubercle.

Of the bird cases, 52 were generalised tubercle, and 6 were of bovine type.

2. All the mould-diseases have been grouped under mycosis. Ten of the mammal cases were in Wallabies, and of the same type as that I have previously described, affecting primarily the jaws; the other 2 were in Cercopitheques in which the infection was localised in the intestines and kidneys. There is a slight decrease in the number of deaths from mycosis in birds, but it is still large, and is 2 per cent. of the total number of birds.

3. There is an increase in the deaths from pneumonia in birds and reptiles. The percentage on the total number of animals is 3·2 for mammals, 2·7 for birds, and 10 for reptiles. It is amongst the reptiles that the increase has been most marked, from 4 in 1908 to 120 in 1912 (these are pneumococcal cases and do not include those due to irritation from worms' eggs and embryos).

4. "Worms" is used in a comprehensive sense; two of the mammals were Indian Buffaloes with an enormous trematode infection of the stomach.

5. This was a ruptured aneurism of the ascending aorta in a Pigeon.

6. In a Duck, after swallowing wire.

7. The percentage of gastro-enteritis is still high: 3·5 for mammals, 4·3 for birds, and 2·4 for reptiles, on the total number of each. It has been noticed during the last year in connection with enteritis in mammals that there has often been an associated condition of gingivitis, not bad enough to call pyorrhœa, which possibly may stand in causal relationship to the enteritis. In 2 mammals it was of coccidial origin, and in 2 others it was due to worms. Of the bird cases 72 were haemorrhagic and 9 were due to foreign bodies. It has much decreased amongst the reptiles, and 6 of the cases in this class were due to worms.

8. Nephritis has increased amongst mammals and birds, having caused the deaths of 6·4 per cent. in the former and 2·9 in the latter. Of the cases in mammals 60 were acute, 10 in condition of "large white" kidney, and 19 in condition of "contracted granular" kidney. In birds it is nearly always chronic, about one-third of the number being of the contracted granular kidney type. A conjunction of climatic conditions with exposure would seem to be answerable for many of the cases in mammals, and 40 out of the 60 acute cases had lung lesions, from congestion to broncho-pneumonia.

9. In a Bay Duiker, the left kidney was converted into multiple cysts containing stones, and there was one large cyst in the right; there was also a haemorrhagic cystitis.

10. The carcinomata were all visceral, and occurred in one Kangaroo and three Gazelles. In all the cases the initial growth was in the stomach, and there were atrophic changes in the sexual glands.

11. The sarcomata occurred in a Binturong (visceral), a Bear (kidneys), an Owl (heart), and a Sternothere (heart).

12. The diseases grouped under the term malaria were due in 31 instances to *Hæmoproteus danilewskyi* and in 6 instances to *Plasmodium præcox*.

12, 13, 14, 15. See the section on blood-parasites.

During the year the blood of every animal which died has been examined, with the result that parasites have been found in 140 cases; in 80 species for the first time.

They have been distributed as follows:—

Filariae. In 3 mammals; in 2 for the first time.

34 birds; in 24 species for the first time.

2 reptiles.

Trypanosomes. In 11 birds; in 6 species for the first time.

Malaria. $\left\{ \begin{array}{l} \text{ } Hæmoproteus danilewskyi. \text{ In 33 birds; in 15 species} \\ \text{for the first time.} \\ \text{ } Plasmodium præcox. \text{ In 7 birds; in 6 species for} \\ \text{the first time.} \end{array} \right.$

Leucocytozoon. In 1 bird for the first time.

Hæmogregarines. In 48 reptiles; in 15 species for the first time.

Intestinal organisms of } In 1 reptile for the first time.

Trichomonas type ... }

The following Tables show the occurrence of the blood-parasites in detail:—

BLOOD-PARASITES FOUND IN 1912.

Embryo Filariae found in the blood of Mammals.

	HABITAT.	TYPE.
Piuchi Marmoset (<i>Leontocebus oedipus</i>)...	Colombia.	Long.
<i>Found in the following for the first time:</i>		
Clouded Tiger (<i>Felis nebulosa</i>)	Malay.	Long, thin, large capsule.
S. American Night-Mouse (<i>Nyctomysh sp. inc.</i>)	C. America.	Short, thick capsule.

Embryo Filariae found in the blood of Birds.

Black-throated Hangnest (<i>Icterus gularis</i>).	S. America.	Short, straight.
2 Blue Birds (<i>Sialia sialis</i>)	N. America.	Short, thick.
Whydah Bird (<i>Urobrachya albnotata</i>).	E. Africa.	Long.
Occipital Blue Pie (<i>Urocissa occipitalis</i>).	India.	Short, thick.
Green-billed Toucan (<i>Ramphastos dicolorus</i>).	Guiana.	Short, thick.
Lawes' Bird of Paradise (<i>Parotia lawesi</i>).	New Guinea.	Long, thick.
White-throated Jay Thrush (<i>Garrulax albicularis</i>).	India.	Long, striated.
Lanceolated Jay (<i>Garrulus lanceolatus</i>).	India.	Short, pointed.

Found in the following for the first time :

	HABITAT.	TYPE.
Crested Black Bunting (<i>Melophus melanicterus</i>). Green Cardinal (<i>Gubernatrix cristata</i>). Gouldian Grass-Finch (<i>Poephila gouldiae</i>). Mynah (<i>Acridotheres tristis</i>) Yellow Sparrow (<i>Passer luteus</i>) Crossbill (<i>Loxia curvirostra</i>) Grey Thrasher (<i>Toxostoma cinereum</i>) ... White-bellied Thrush (<i>Turdus albiventris</i>). Red Jungle-Fowl (<i>Gallus gallus</i>) 2 Blue-crowned Hanging Parrakeets (<i>Loriculus galgulus</i>). White-cheeked Coly (<i>Colius erythromelas</i>). Rufous-tailed Pheasant (<i>Acoumus erythrophthalmus</i>). Woodhouse's Jay (<i>Aphelocoma woodhousei</i>). Hermit Thrush (<i>Hylocichla guttata pallasi</i>). Burrowing Owl (<i>Speotyto cunicularia hypogea</i>). Little Owl (<i>Athene noctua</i>) Purple Grackle (<i>Quiscalus purpureus</i>) ... Mexican Jay (<i>Xanthura luxuosus</i>) Grey-headed Ouzel (<i>Merula castanea</i>) ... Rufous-necked Weaver-bird (<i>Hyphantornis textor</i>). Green Bulbul (<i>Chloropsis aurifrons</i>) ... Drongo (<i>Dissemurus paradiseus</i>) Red-headed Weaver-bird (<i>Foudia madagascariensis</i>). Scops Owl (<i>Scops giu</i>)	India. S. America. Australia. India. E. Africa. Europe. Lr. California. Demerara. Malay. Malay. S. Africa. Malay. N. America. N. America. C. America. S. Europe. N. America. S. America. India. Gambia. India. India. Madagascar. N. Europe.	Long, thick. Short, pointed. Short. Long and thin. Long. Long. Long. Long. Long, thick. Short, thick. Long, thick. Long, thick. Short, thick. Long, striated. Long, thin. Short, thick. Long, thick. Long, pointed, and with very large capsule. Short. Very short, stout. Long, thin. Short, thick. Long. Long. Long, striated.

: Embryo Filariae found in the blood of Reptiles.

Edible Frog (<i>Rana esculenta</i>)	S. Europe.	Short, thick.
Pine Snake (<i>Pituophis sayi</i>)	N. America.	Long.

Trypanosomes found in the blood of Birds.

Dial Bird (<i>Copsychus saularis</i>)	India.
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Found in the following for the first time :

Blue Bird (<i>Sialia sialis</i>)	N. America.
Whydah Bird (<i>Urobrachya albonotata</i>). Gouldian Grass-Finch (<i>Poephila gouldiae</i>). 2 Grey Thrashers (<i>Toxostoma cinereum</i>). 4 Blue-crowned Hanging Parrakeets (<i>Loriculus galgulus</i>). Wandering Tree-Pie (<i>Dendrocitta vagabunda</i>). These were all of the ordinary type of bird Trypanosomes.	E. Africa. Australia. Lr. California. Malay. India.

Hæmoproteus danilewskyi found in the blood of Birds.

		HABITAT.	TYPE.
Yellow-winged Sugar-Bird (<i>Cæreba cyanea</i>). 11 Blue-crowned Hanging Parrakeets (<i>Loriculus galgulus</i>).		S. America. Malay.	
Cape Sparrow (<i>Passer arcuata</i>)		S. Africa.	
Crossbill (<i>Loxia curvirostra</i>)		Europe.	
Little Owl (<i>Athene noctua</i>)		Europe.	

Found in the following for the first time :—

2 Pratincoles (<i>Glareola pratincola</i>)	India.
3 Silver-eared Mesias (<i>Mesia argenteauris</i>). De Philippi's Meadow-Starling (<i>Sturnella defilippi</i>).	India. Chili.
Whydah Bird (<i>Penthetria laticauda</i>) ...	E. Africa.
Jerdon's Accentor (<i>Tharrhaleus jerdoni</i>).	India.
Banded Parrakeet (<i>Palaeornis fasciatus</i>).	India.
Crested Black Bunting (<i>Melophus melan- icterus</i>).	India.
Yellow-throated Sparrow (<i>Gymnorhis flavigollis</i>).	India.
White-throated Jay-Thrush (<i>Garrulax albicularis</i>).	India.
Yellow-headed Reed-bird (<i>Agelaius ictero- cephalus</i>).	Mexico.
Rufous-necked Weaver-bird (<i>Hyphant- ornis textor</i>).	Gambia.
Red-headed Weaver-bird (<i>Foudia mada- gascariensis</i>).	Madagascar.
Wandering Tree-Pie (<i>Dendrocitta vaga- bunda</i>).	India.
Swainson's Francolin (<i>Pternistes swainsoni</i>).	S. Africa.
Red Jungle-Fowl (<i>Gallus gallus</i>)	Malay.

*Plasmodium praecox found in the blood of Birds :
in all for the first time.*

Grey-headed Bunting (<i>Emberiza fucata</i>).	India.
Crested Black Bunting (<i>Melophus melan- icterus</i>).	India.
Raven (<i>Corvus corax</i>)	Europe.
2 Crossbills (<i>Loxia curvirostra</i>)	Europe.
Pied Bush-Chat (<i>Pratincola caprata</i>) ...	India.
Grey Thrasher (<i>Toxostoma cinereum</i>) ...	Lr. California.

*Leucocytozoon found in the blood of the following Bird
for the first time.*

Scops Owl (<i>Scops givu</i>)	N. Europe.
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Hæmogregarines found in the blood of Reptiles.

4 Common Boas (<i>Boa constrictor</i>)	S. America.	Long, host cells enlarged.
2 Indian Pythons (<i>Python molurus</i>) ...	India.	Medium, cells deformed.

	HABITAT.	TYPE.
3 King Snakes (<i>Coronella getula</i>)	N. America.	Small, short.
Teguexin (<i>Tupinambis teguixin</i>)	S. America.	Large, granular cells enlarged.
Eyed Lizard (<i>Lacerta ocellata</i>)	S. Europe.	Long, thin, host-cells enlarged.
4 Dark Green Snakes (<i>Zamenis gemonensis</i>). Russell's Viper (<i>Vipera russelli</i>)	S. Europe. India.	Small, host-cells enlarged. Long.
2 Rat-Snakes (<i>Zamenis mucosus</i>)	India.	Medium sized.
Indian Cobra (<i>Naia tripudians</i>)	India.	Long.
Tuberculated Iguana (<i>Iguana tuberculata</i>). Indian Eryx (<i>Eryx johni</i>)	S. America. India.	Short. Long.
4 Diamond Rattlesnakes (<i>Crotalus atrox</i>). 2 Pine Snakes (<i>Pituophis sayi</i>)	N. America.	Large, host-cells enlarged.
Vivaceous Snake (<i>Taraphis fallax</i>) ... Green Mamba (<i>Dendraspis viridis</i>)	S. Europe. W. Africa.	Long, cells enlarged. Medium.
European Pond-Tortoise (<i>Emys orbicularis</i>). Long-nosed Viper (<i>Vipera ammodytes</i>) .	S. Europe. S. Europe.	Large. Short, thick.
		Large.

Found in the following for the first time:—

Robust Lizard (<i>Gerrhosaurus nigrolineatus</i>). Angulated Tortoise (<i>Testudo angulata</i>) .	Cape Colony. S. Africa.	Large, granular, host-cells enlarged.
Schott's Snake (<i>Philodryas schotti</i>)	S. America.	Large, irregular.
Copper-headed Viper (<i>Ancistrodon contortrix</i>). Common Krait (<i>Bungarus candidus</i>) ...	Texas. India.	Small, short.
Hamadryad (<i>Naia bungarus</i>)	India.	Long; snake had been 12 years in Gardens.
Calabar Snake (<i>Calabaria reinhardtii</i>) ... Blood-stained Terrapin (<i>Cinosternum cruentatum</i>). Indian River-Snake (<i>Tropidonotus pectoralis</i>). Baska Water-Tortoise (<i>Batagur baska</i>) .	W. Africa. C. America. India. Perak.	Medium.
2 Phayre's Tortoises (<i>Testudo emys</i>)	Malay.	Long.
2 Thick-necked Tree-Boas (<i>Epicrates cenchris</i>). Carpet-Viper (<i>Echis carinatus</i>)	Trinidad. N. Africa.	Long, thick.
Water-Viper (<i>Ancistrodon piscivorus</i>)... Amboina Box-Tortoise (<i>Cyclemys amboinensis</i>). Malay.	N. America. Malay.	Stout.
		Long, cells enlarged.
		Large, cells enlarged.
		Thick, cells enlarged.
		Short, thick.

*Intestinal Organisms found in the blood of Reptiles.**Found for the first time in the following:—*

Amboina Box-Tortoise (<i>Cyclemys amboinensis</i>).	Malay.	Trichomonas.
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EXHIBITIONS AND NOTICES.

February 4, 1913.

Sir JOHN ROSE BRADFORD, K.C.M.G., F.R.S., Vice-President,
in the Chair.

THE SECRETARY read the following report on the additions made to the Society's Menagerie during the months of November and December, 1912:—

NOVEMBER.

The registered additions to the Society's Menagerie during the month of November were 161 in number. Of these 65 were acquired by presentation, 66 by purchase, 11 were received on deposit, 9 in exchange, and 10 were born in the Gardens.

The total number of departures during the month, by death and removals, was 229.

Amongst the additions special attention may be called to the following:—

1 Humboldt's Saki (*Pithecia monachus*), from Iquitos, purchased on November 20th.

1 Kusimanse (*Crossarchus obscurus*), from Axim, Gold Coast, presented by R. W. Brent, Esq., on November 8th.

2 Black-spined Porcupine Anteaters or Echidnas (*Zaglossus nigroaculeatus* ?), from Charles Louis Mountains, New Guinea, new to the Collection, deposited on November 27th.

DECEMBER.

The registered additions to the Society's Menagerie during the month of December were 79 in number. Of these 40 were acquired by presentation, 4 by purchase, 17 were received on deposit, 7 in exchange, and 11 were born in the Gardens.

The total number of departures during the month, by death and removals, was 168.

Amongst the additions special attention may be called to the following:—

2 Ruffed Lemurs (*Lemur varius*) ♂ ♀, received in exchange on December 16th.

1 White-tailed Gnu (*Connochaetes gnu*) ♀, purchased on December 10th.

3 Mahali Weaver-birds (*Plocepasser mahali*), from South Africa, new to the Collection, received in exchange on December 17th.

1 Pink-browed Rose-Finch (*Propasser rhodochrous*), from the Himalayas, new to the Collection, presented by W. H. St. Quintin, Esq., F.Z.S., on December 19th.

1 Nepalese Eagle-Owl (*Huhua nipalensis*), from the Maikola Valley, East Nepal, purchased on December 4th.

1 Bushmaster (*Lachesis mutus*), from Trinidad, presented by the Baron Leijonhufvud, F.Z.S., on December 10th.

Mr. D. SETH-SMITH, F.Z.S., Curator of Birds, exhibited a female Carolina Duck (*Lampronessa sponsa*) which had partially assumed the male plumage. It had shown no sign of this condition before the last moult. It now resembled the male in most respects, although the colours were duller and the characteristic markings less clearly defined, but it retained the brown colouring of the eye and the yellow skin and white patch of feathers surrounding it, which were characters of the female.

Mr. E. G. BOULENGER, F.Z.S., Curator of Reptiles, exhibited a blue specimen of the Edible Frog (*Rana esculenta*) which he had obtained from Tuscany. The blue colour was attributed to the absence of yellow pigment, which is present in large quantities in green frogs. This aberration is not very unfrequent in the European Tree-Frog (*Hyla arborea*), but very rare in the Edible Frog, and this was the first occasion on which such a specimen had been exhibited in the Gardens. Blue Edible Frogs have been previously reported from France, Western Germany, and Switzerland.

Mr. BOULENGER also exhibited a living specimen of the remarkable Lizard *Pygopus lepidopus*, a species which is rarely seen alive in this country, and which had not been represented in the Society's Collection for some considerable time.

February 18, 1913.

Prof. E. A. MINCHIN, M.A., F.R.S., Vice-President,
in the Chair.

THE SECRETARY read the following report on the additions that had been made to the Society's Menagerie during the month of January, 1913 :—

The number of registered additions to the Society's Menagerie during the month of January last was 120. Of these 38 were acquired by presentation, 70 by purchase, 1 was received on deposit, 1 in exchange, and 10 were born in the Gardens.

The total number of departures during the same period, by deaths and removals, was 189.

Amongst the additions special attention may be directed to :—

1 American Bison (*Bison americanus*) ♀, from N. America, received in exchange on January 16th.

2 Barbary Apes (*Macacus inuus*) ♂ ♀, from Gibraltar, presented by Major C. E. P. Fowler, R.A.M.C., on January 1st.

2 Arabian Baboons (*Papio hamadryas*), from Arabia, 1 Anubis Baboon (*Papio anubis*), from W. Africa, 2 Mandrills (*Papio mainon*) ♂ ♀, from W. Africa, 1 Egyptian Mongoose (*Mungos ichneumon*), from Egypt, 1 Indian Green Barbet (*Thereiceryx zeylonicus*), from India, 1 Iceland Falcon (*Hierofalco islandus*), from Iceland, and 2 Black-necked Crowned Cranes (*Balearica pavonina*), from Nigeria, presented by W. O. Danckwerts, Esq., K.C., F.Z.S., on January 22nd, 24th, and 28th.

3 Cuban Black Bullfinches (*Melopyrrha nigra*), purchased on January 11th.

5 South-African Ostriches (*Struthio australis*), bred in Australia, purchased on January 6th.

Mr. E. G. BOULENGER, F.Z.S., Curator of Reptiles, exhibited spines of a hedgehog-like Madagascar Insectivore, *Ericulus setosus*, which had been found by Mr. C. R. Walter in the excrement of a *Boa madagascariensis*, this being probably the first instance on record of a Snake swallowing a spiny mammal.

The SECRETARY, Dr. P. CHALMERS MITCHELL, F.R.S., F.Z.S., exhibited a series of lantern-slides showing the opening and closing of the patch of white hairs forming the dorsal band in a living Tree-Hyrax (*Dendrohyrax dorsalis*).

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

November 26th, 1912.

Dr. A. SMITH WOODWARD, F.R.S., Vice-President, in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

Mr. OLDFIELD THOMAS, F.R.S., F.Z.S., exhibited and made remarks on a peculiar Amazonian Monkey (*Callimico goeldii*) which showed characters intermediate between those of the ordinary American Monkeys (*Cebidae*) and of the Marmosets (*Callitrichidae*).

Mr. C. TATE REGAN, M.A., F.Z.S., exhibited male and female examples of *Cynolebias bellottii*, a Cyprinodont Fish from the La Plata, to illustrate the remarkable sexual characters.

A paper entitled "On the Structure of Bone in Fishes: a Contribution to Palaeohistology," was read by Mr. E. S. GOODRICH, M.A., F.R.S., F.Z.S. He stated that a microscopic examination of the bone of the Actinopterygian Fishes showed that in those groups which are provided with lepidosteoid ganoid scales [Amioidei (Protospondyli) and Lepidosteoiidei (Aethespondyli)] the characteristic lepidosteoid histological structure extended throughout the endoskeleton as well as the dermal bones. No other fishes are known to have this lepidosteoid structure, either in the scales or in the skeleton.

A paper on the Land Crayfishes of Australia was received from Messrs. GEOFFREY W. SMITH, M.A., and E. H. J. SCHUSTER, M.A., D.Sc., F.Z.S.

This paper dealt with the genus *Engaeus*, a group of Victorian

* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings', free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of Sixpence, or, if desired, sent post-free for the sum of Six Shillings per annum, payable in advance.

and Tasmanian Crayfishes, which have forsaken the water and excavate burrows in damp soil. In certain mining districts on the west coast of Australia they do much damage to the artificial water-courses by riddling through the banks and dams and causing them to collapse.

Although the tunnel leading to the heart of the burrow is free from water, there is always water in the circular chambers at the end where the Crayfish lives.

In a former paper it was suggested that these Crayfishes of the genus *Engaeus* are derived from the genus *Parachæraps*, which has spread from Western Australia into the desert regions of the centre, and is now found in all parts of continental Australia; but conclusive evidence is brought forward in this paper to show that *Engaeus* is derived from the South-eastern and Tasmanian genus *Astacopsis*, and that its superficial resemblance to *Parachæraps* is due to convergence owing to similar habits.

A striking peculiarity of the eight species of *Engaeus* is the very great range of structural differences which they exhibit compared with other Crayfishes, differences which are far greater and concern more important characters than those which distinguish genera or even families of other Crayfishes. Thus in some species a gill may be entirely suppressed, in others half a limb (*e. g.*, the exopodite of the third maxillipede) is absent, in others the flagellum of the antennule. All these characters are of the nature of degenerations, apparently incident on the subterranean mode of life. Apart from these differences, the species are obviously closely related and represent a monophyletic group.

A paper was communicated by Dr. C. L. BOULENGER, M.A., F.Z.S., dealing with the Myzostomida collected by Mr. Cyril Crossland in the Red Sea in 1905, and containing descriptions of three species, of which one is new. A complete account of the anatomy of this form is given, as well as that of *M. costatum* F. S. L. The latter species is described as possessing six pairs of ventral "suckers," the largest number recorded in any member of the group.

The Hon. PAUL A. METHUEN, F.Z.S., contributed a paper containing the description of a new Amphipod, belonging to the family Talitridæ, which had been obtained in the Woodbush district of Northern Transvaal.

A paper by Mr. BRUCE F. CUMMINGS, communicated by the SECRETARY, and entitled "On some Points in the Anatomy of the Mouth-parts of the Mallophaga," dealt with some peculiar structures in the floor of the mouth-cavity of the Mallophaga, or the biting bird-parasites, and known as the *œsophageal sclerite* and *lingual glands*. The "glands" are determined as chitinous, and

both sclerite and glands together are regarded as a compound hypopharynx. Variations of the structures in various genera of the two suborders of the Mallophaga are described and figured and the homologies of the parts indicated. Attention is drawn to the value of the hypopharynx as a character in splitting up unwieldy genera. The writer further describes the problematic "maxillary forks"—delicate chitinous splints lying unattached within the mouth, one on either side of the hypopharynx,—and suggests that they are the third pair of maxillæ, known as maxillulæ or superlinguae of the hypopharyngeal or fifth segment of the insect head, well developed in many primitive insects such as the Apterygota, and probably also in certain beetle larvæ.

The next Meeting of the Society for Scientific Business will be held on Tuesday, February 4th, 1913, at half-past Eight o'clock P.M., when the following communications will be made:—

F. E. BEDDARD, M.A., D.Sc., F.R.S., F.Z.S.

Contributions to the Anatomy and Systematic Arrangement of the Cestoidea.—VIII, On some Species of *Ichthyotenia* and *Ophidotaenia* from Ophidia.

H. G. PLIMMER, F.R.S., F.L.S., F.Z.S.

Report on the Deaths which occurred in the Zoological Gardens during 1912.

H. L. HAWKINS, M.Sc., F.G.S.

The Anterior Ambulacrum of *Echinocardium cordatum* Penn., and the Origin of Compound Plates in Echinoids.

G. P. FARRAN.

Plankton from Christmas Island, Indian Ocean.—II. On Copepoda of the Genera *Oithona* and *Paroithona*.

The following papers have been received :—

H. B. PRESTON, F.Z.S.

Diagnoses of new Species and Varieties of Agnathous Mollusca.

R. LYDEKKER, F.R.S., F.Z.S.

The Dwarf Buffalo of Southern Nigeria: with a Revision of the Dwarf Buffaloes of Western Africa.

W. A. LAMBORN, M.R.C.S.

A few Notes on the Habits of certain Reptiles in the Lagos District.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,

Secretary.

ZOOLOGICAL SOCIETY OF LONDON,

REGENT'S PARK, LONDON, N.W.

December 3rd, 1912.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

February 4th, 1913.

Sir JOHN ROSE BRADFORD, K.C.M.G., F.R.S.,
Vice-President, in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a Report on the Additions made to the Society's Menagerie during the months of November and December, 1912.

Mr. D. SETH-SMITH, F.Z.S., Curator of Birds, exhibited a female Carolina Duck (*Lampronessa sponsa*) which had partially assumed the male plumage. It had shown no sign of this condition before the last moult. It now resembled the male in most respects, although the colours were duller and the characteristic markings less clearly defined, but it retained the brown colouring of the eye and the yellow skin and white patch of feathers surrounding it, which were characters of the female.

Mr. E. G. BOULENGER, F.Z.S., Curator of Reptiles, exhibited a blue specimen of the Edible Frog (*Rana esculenta*) which he had obtained from Tuscany. The blue colour was attributed to the absence of yellow pigment, which is present in large quantities in green frogs. According to Mr. G. A. Boulenger, this aberration is not very unfrequent in the European Tree-Frog (*Hyla arborea*),

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but very rare in the Edible Frog, and this was the first occasion on which such a specimen had been exhibited in the Gardens. Blue Edible Frogs have been previously reported from France, Western Germany, and Switzerland.

Mr. BOULENGER also exhibited a living specimen of the remarkable Lizard *Pygopus lepidopodus*, a species which is rarely seen alive in this country, and which had not been represented in the Society's Collection for some considerable time.

Dr. F. E. BEDDARD, M.A., F.R.S., F.Z.S., Prosector to the Society, read a paper, the eighth of the series, on the Anatomy and Systematic Arrangement of the Cestoidea, in which he dealt with a number of new species of *Ichthyotænia* and *Ophidotænia* obtained from the gut of Serpents that had died in the Gardens.

Mr. H. G. PLIMMER, F.R.S., F.Z.S., Pathologist to the Society, presented his annual report on the deaths which occurred in the Society's Gardens during the past year, together with a list of the Blood Parasites found during the same period. An examination had been made of the blood of every animal that had died, with the result that parasites had been discovered in 140 cases, and in 80 of these for the first time.

Mr. HERBERT L. HAWKINS, M.Sc., F.G.S., read a paper, communicated by Dr. F. A. BATHER, M.A., F.R.S., F.Z.S., on "The Anterior Ambulacrum of *Echinocardium cordatum* and the Origin of Compound Plates in the Echinoidea." It contained the description of a new method of exposing sutures in recent Echinoids suitable for photographic purposes, the process combining staining with etching, and the description of the complex plating of ambulacrum III, in *Echinocardium cordatum*. The origin of ambulacral "plate-crushing," founded on a brief survey of the phenomenon in all groups of Echinoids, was discussed. Mechanical growth-pressure was regarded as the cause, with the growth of tubercles (Lambert's hypothesis) as a secondary and merely modifying agent.

Mr. G. P. FARRAN presented a paper, communicated by Dr. W. T. CALMAN, F.Z.S., entitled "Plankton from Christmas Island, Indian Ocean.—II. On Copepoda of the Genera *Oithona* and *Paroithona*." This collection, made in 1908 by Sir John Murray, K.C.B., F.R.S., and Dr. C. W. Andrews, F.R.S., contained eleven species of *Oithona* and one of *Paroithona*, or rather more than half the known species, the total number of known species of *Oithona* being eighteen and of *Paroithona* two. This indicated the great richness in species of collections made in tropical waters.

Seven of the species of *Oithona* and the one *Paroithona* appeared to be new to science. A diagnostic table of all the known species of both genera was included in the paper.

The next Meeting of the Society for Scientific Business will be held on Tuesday, February 18th, 1913, at half-past Eight o'clock p.m., when the following communications will be made:—

EXHIBITIONS AND NOTICES.

H. B. PRESTON, F.Z.S.

Diagnoses of new Species and Varieties of Agnathous Mollusca from Equatorial Africa.

R. LYDEKKER, F.R.S., F.Z.S.

The Dwarf Buffalo of Southern Nigeria: with a Revision of the Dwarf Buffaloes of Western Africa.

W. A. LAMBORN, M.R.C.S.

A few Notes on the Habits of certain Reptiles in the Lagos District.

G. STEWARDSON BRADY, M.D., LL.D., D.Sc., F.R.S., C.M.Z.S.

On Two British Entomostraca belonging to the Orders Copepoda and Ostracoda.

R. BROOM, M.D., D.Sc., C.M.Z.S.

On the Gorgonopsia, a Suborder of the Mammal-like Reptiles.

The following papers have been received:—

ARTHUR WILLEY, M.A., D.Sc., F.R.S., F.Z.S.

Notes on Plankton collected across the Mouth of the St. Croix River opposite to the Biological Station at St. Andrews, N.B., in July and August, 1912.

FRANK E. BEDDARD, D.Sc., M.A., F.R.S., F.Z.S.

Contributions to the Anatomy and Systematic Arrangement
of the Cestoidea.—IX. On a New Genus of Ichthyotæniids.

EDITH E. BAMFORD.

Variations in the Skeleton of the Pectoral Fins of *Polypterus*.

Communications intended for the Scientific Meetings should
be addressed to

P. CHALMERS MITCHELL,
Secretary.

ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W.

February 11th, 1913.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

February 18th, 1913.

Prof. E. A. MINCHIN, M.A., F.R.S.,
Vice-President, in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a Report on the Additions made to the Society's Menagerie during the month of January, 1913.

Mr. E. G. BOULENGER, F.Z.S., Curator of Reptiles, exhibited spines of a Madagascar Hedgehog (*Ericulus*), which had been found by Mr. C. R. Walter in the excrement of a Boa (*B. madagascariensis*), this being probably the first instance on record of a Snake swallowing a spiny mammal.

The SECRETARY, Dr. P. CHALMERS MITCHELL, F.R.S., F.Z.S., exhibited a series of lantern-slides showing the opening and closing of the patch of white hairs forming the dorsal stripe in a living Tree-Hyrax (*Dendrohyrax dorsalis*).

Mr. H. B. PRESTON, F.Z.S., read a paper entitled "Diagnoses of new Species and Varieties of Agnathous Mollusca from Equatorial Africa." He drew attention to the enormous field for conchological research awaiting the student of this very fruitful region, and stated that in many parts each range of hills appeared to have, to a certain extent, its own special molluscan

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fauna, often characterized by certain local and peculiar phases common not only to the species but also to the genera occurring in that particular locality.

Mr. W. A. LAMBORN, M.R.C.S., presented a paper, communicated by Prof. E. B. POULTON, F.R.S., F.Z.S., containing some notes on the habits of certain Reptiles in the Lagos district. It contained an account of the habits of the Lizard *Agama colonorum*, especially relating to courtship, polygamous practices, and combativeness, and of native superstitions in regard to Chameleons. Observations were also recorded on a batch of eggs of a Crocodile, probably *Crocodilus niloticus*, on their hatching, on the behaviour of the newly-hatched young, and on the native beliefs as to the habits of the mother crocodile.

A paper presented by Dr. R. BROOM, M.D., C.M.Z.S., entitled "On the Gorgonopsia, a suborder of the Mammal-like Reptiles," contained the descriptions of a new genus and two new species of Gorgonopsids, based on well-preserved skulls discovered by Mr. S. H. Haughton and the Rev. J. H. Whaits. The Gorgonopsia were re-established as a distinct suborder of the Therapsida, and a list of the characters distinguishing the Gorgonopsians from the Therocephalians was given.

A second paper from Dr. Broom dealt with the South African Rhynchocephaloid Reptile *Euparkeria capensis*. A detailed account of this species was given, and its affinities with allied forms discussed. The evidence at present seemed to show that *Euparkeria* was to be regarded as a member of an order of generalised Rhynchocephaloid Reptiles, and might be taken as the type of a most important suborder of this group containing the ancestors of the Dinosaurs, the Pterodactyles, and the Birds.

Mr. R. LYDEKKER, F.R.S., F.Z.S., described the heads of a male and female Dwarf Buffalo shot by Lieut. A. W. Hunt, R.N., in Southern Nigeria, for which the name *Bos caffer hunti* was suggested. This race agrees with the Gambian *B. c. planiceros* in that the adult bulls are darker than cows, but is of smaller size, with the orange band on the throat narrower. Mr. Lydekker also proposed the name *B. c. beddingtoni* for a mounted bull of a Red Dwarf Buffalo from Ashanti, mainly on the ground that it is cut off from the Red Congo *B. c. nanus* by the above-mentioned Nigerian race.

Dr. G. STEWARDSON BRADY, D.Sc., F.R.S., C.M.Z.S., contributed a paper containing the descriptions of two British Entomostraca apparently new to science—one a *Diaptomus* obtained abundantly in Loch Ness many years ago but hitherto unnoticed; the other

an Ostracod, of which one specimen only was found in brackish water in Sussex. The latter formed the type of a new genus, and possibly also a new family.

The next Meeting of the Society for Scientific Business will be held on Tuesday, March 4th, 1913, at half-past Eight o'clock P.M., when the following communications will be made :—

EXHIBITIONS AND NOTICES.

FRANK E. BEDDARD, D.Sc., M.A., F.R.S., F.Z.S.

Contributions to the Anatomy and Systematic Arrangement of the Cestoidea.—IX. On a New Genus of Ichthyotæniids.

W. A. CUNNINGTON, M.A., Ph.D., F.Z.S.

Zoological Results of the Third Tanganyika Expedition conducted by Dr. W. A. Cunnington, 1904–1905.—Report on the Branchiura.

WILLIAM SCHAUS, F.Z.S.

New Species of Rhopalocera from Costa Rica.

ARTHUR WILLEY, M.A., D.Sc., F.R.S., F.Z.S.

Notes on Plankton collected across the Mouth of the St. Croix River opposite to the Biological Station at St. Andrews, New Brunswick, in July and August, 1912.

The following paper has been received :—

EDITH E. BAMFORD.

Variations in the Skeleton of the Pectoral Fins of *Polypterus*.

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ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W.

February 25th, 1913.

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The 'Proceedings' for the year are issued in *four* parts, paged consecutively, so that the complete reference is now P. Z. S. 1913, p. . . . The Distribution is as follows:—

Part I. issued in March.

" II. " June.

" III. " September.

" IV. " December.

" Proceedings," 1912, Part IV. (pp. 757-913), were published on
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1913.

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THE ZOOLOGICAL SOCIETY OF LONDON.

THIS Society was founded in 1826 by Sir STAMFORD RAFFLES, Mr. J. SABINE, Mr. N. A. VIGORS, and other eminent Naturalists, for the advancement of Zoology and Animal Physiology, and for the introduction of new and curious subjects of the Animal Kingdom, and was incorporated by Royal Charter in 1829.

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The Office of the Society, Regent's Park, N.W., where all communications should be sent, addressed to "The Secretary," is open from Ten till Five, except on Saturdays, when it closes at ONE P.M.

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The Meetings of the Society for General Business are held in the Meeting Room at the Society's Office on the third Wednesday in every month of the year, except in September and October, at half-past Four o'clock P.M.

The Meetings for Scientific Business are held in the Meeting Room at the Society's Office fortnightly on Tuesdays, except in July, August, September, and December and January, at half-past Eight o'clock P.M.

The Anniversary Meeting is held on the 29th. of April, or the nearest convenient day, at Four P.M.

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Ladies or Gentlemen wishing to become Fellows of the Society are requested to communicate with "The Secretary."

P. CHALMERS MITCHELL,
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Regent's Park, London, N.W.,
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An "Abstract of the Proceedings" is published by the Society on the Tuesday following the date of the Scientific Meeting to which it refers. It is issued along with the "Proceedings," free of extra charge, to all Fellows who subscribe to the Publications, but it may be obtained on the day of publication at the price of Sixpence, or, if desired, sent post free for the sum of Six Shillings per annum, payable in advance.

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[Received November 4, 1912: Read February 4, 1913.]

VIII. ON SOME SPECIES OF *Ichthyotænia* AND *Ophidotænia*
FROM OPHIDIA.

(Text-figures 33–38.)

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In the present communication I lay before the Society the result of an investigation into the anatomy of a number of species of tapeworms which I have obtained during the last three years from the gut of serpents, and all of which are members of the family Ichthyotæniidae.

The parasites of serpents are obviously but incompletely known at present. The only well-known genera which have been seen in those reptiles are *Solenophorus* from certain pythons *, a few species of *Ichthyotænia* † from various species of serpents, *Crepidobothrium* ‡ from boas, *Ophidotænia* § from the Indian cobra, *Oochoristica* || from *Zamenis viridiflavus*.

Ichthyotænia gabonica, sp. n.

I obtained on June 21, 1912, a number of tapeworms from *Bitis gabonica*, which I refer to a new species and name as above. I am not able to give the exact length of the worm, but the largest piece which I measured was 150 mm. We are safe, therefore, in allowing its length to be not less than 160 mm., and probably rather more. The scolex is intermediate in size between that of such species as *Crepidobothrium gerrardi*, which has a particularly large scolex, and such species as *Ophidotænia naiae*, which has a particularly small one. The transverse diameter is about two-thirds of a millimetre. As the greater part of the scolex is taken up by the suckers, each of these is fully a quarter

* Bronn's "Thiereichs," Bd. iv. Abth. 1 B, and literature therein cited.

† v. Linstow, "Helminthen von Java," Notes Leyd. Mus. xxix. 1908, p. 85.

‡ Monticelli, Atti Soc. Nat. e Mat. Modena (4) i. 1899, p. 9.

§ Beddard, P. Z. S. 1913, p. 25; also Schwarz, "Ichthyotæniiden d. Rept.," Inaug.-Diss. Basel, 1908.

|| Zschokke, "Das Genus *Oochoristica*," Zeitschr. wiss. Zool. lxxxiii. 1905.

of a millimetre across. The rostellar region of the scolex is very small in the contracted condition, as is the case with other Ophidian Ichthyotæniids. The suckers look outwards and rather upwards. The length of the scolex is not more than half its breadth. Immediately after the scolex there is a neck in which no segmentation is visible; it is as wide as the scolex, and the body rapidly attains to its greatest width, there being thus no long and thin anterior region.

The segments become elongated as they mature, and attain to a length of four or five times their breadth, or even perhaps rather more. In this species, as in others of the genus, the genital pores alternate in position from side to side of the body, and the relative positions of the cirrus-sac and vagina also alternate.

The *calcareous bodies* in this species are very abundant; they extend into the neck region, where they are very plain, in transverse sections, forming a layer in the cortical parenchyma, not very far below the subcuticular layer. They are also apparent in the scolex. I have frequently observed in posterior segments of the body that the centre of the calcareous bodies is deep black, due to pigment. In sections through the scolex the four suckers are seen to occupy nearly the whole of the area available, there being but little space between them. The thickness of the suckers is much greater actually and relatively than in the allied *Acanthotænia*, which I have recently described *. An examination of these sections failed to show any spiny covering of the body round or in the suckers such as is so conspicuous in *Acanthotænia*. I am convinced that such a spiny covering is entirely absent.

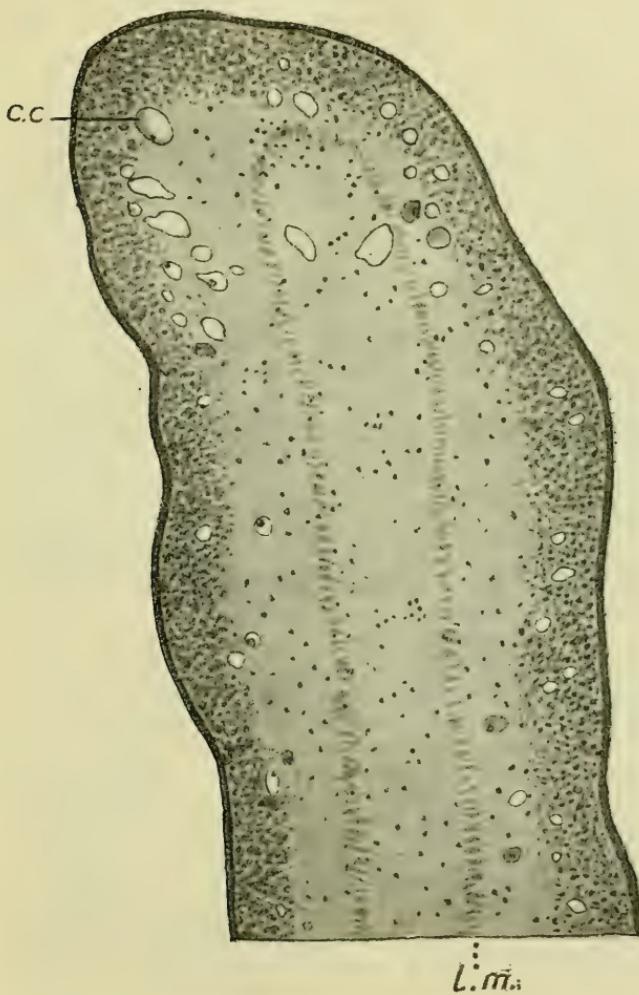
Sections through the scolex also show the slender muscular fibres which effect the movements of the latter. These fibres do not form bundles, but pervade singly the region lying between the suckers. I have pointed out in a previous communication † that the stout muscles of the suckers in the genus *Acanthotænia* concentrate themselves in the neck into very marked and thick bundles of rather thick fibres, which are continued back for a short distance only. It appeared to me when comparing that genus with *Ichthyotænia*, that *Acanthotænia* was to be probably distinguished from *Ichthyotænia* by, *inter alia*, this presence of a thick layer of longitudinal muscles in the neck and by the absence of such a layer in the trunk region, this latter layer being present in *Ichthyotænia*. The examination of the species which forms the subject of the present memoir confirms that opinion; for in *Ichthyotænia gabonica* I have not been able to detect a longitudinal layer of fibres in the neck region; the slender fibres already referred to which effect the movements of the suckers do not become concentrated in the neck into a thick series of bundles as in *Acanthotænia*; nor indeed could I discover any layer at all of such muscles in this part of the body.

* P. Z. S. 1913, p. 8, text-fig. 1.

† P. Z. S. 1913, p. 9, text-fig. 2.

In the posterior part of the body, however, (see text-fig. 33) behind the neck a longitudinal layer of muscles was very clear in

Text-fig. 33.



Transverse section through part of proglottid of *Ichthyotenia gabonica*.

l.m. Longitudinal muscles. *c.c.* Calcareous bodies.

Ichthyotenia gabonica as in other *Ichthyotenia*s from serpents, including my genus and species *Ophidotenia naiae**. This layer

* P. Z. S. 1913, p. 25.

divided off the cortical from the medullary parenchyma and lay therefore at a distance from the outside of the body of about one-third of the entire vertical diameter on each side ; that is to say, the medullary parenchyma in this species is of about the same diameter as the cortical layer. The fibres are strong and are disposed in a layer which varies from one to three fibres thick. They stand out so conspicuously from the general parenchyma of the body that it would be impossible to miss them. In *Ophidotænia* this layer, although in reality plain enough, does not strike the eye so forcibly. I am indeed reminded by their appearance of the figure of the same muscles in *Palaia varani* given in his account of that species by Dr. Shipley* ; and it will be remembered that I have myself ventured to consider that *Palaia* may be really identical with *Ichthyotænia*, or at least near to it †.

This layer of longitudinal muscles does not form a complete layer surrounding the medullary parenchyma. It is interrupted at its two ends by the nerve-cord which is partly within and partly without the medullary region. Dr. Schwarz has laid some stress upon the fact that the transverse layer of muscular fibres in the genus *Ichthyotænia* at least occasionally runs within the medullary parenchyma, occupying the greater part of that region, and the figure already quoted from Dr. Shipley's memoir shows something of the same kind in *Palaia varani*. There is no doubt that in *Ichthyotænia gabonica* the medullary parenchyma is pervaded by slender muscular fibres running transversely and scattered through it fairly uniformly, but not anywhere very close together. I imagine that this is the same appearance that has been seen and described by the two authors quoted. These fibres are definitely muscular fibres, and not the usual parenchymal meshwork arranged in a more markedly transverse fashion. The last point in the general structure of the body to which I shall refer is the subcuticular layer. This layer is several cells thick ; but it is by no means so conspicuous as in *Acanthotænia* and *Ophidotænia* and apparently in some other species of *Ichthyotænia*, since in these three genera the individual cells are much larger than in *Ichthyotænia gabonica*.

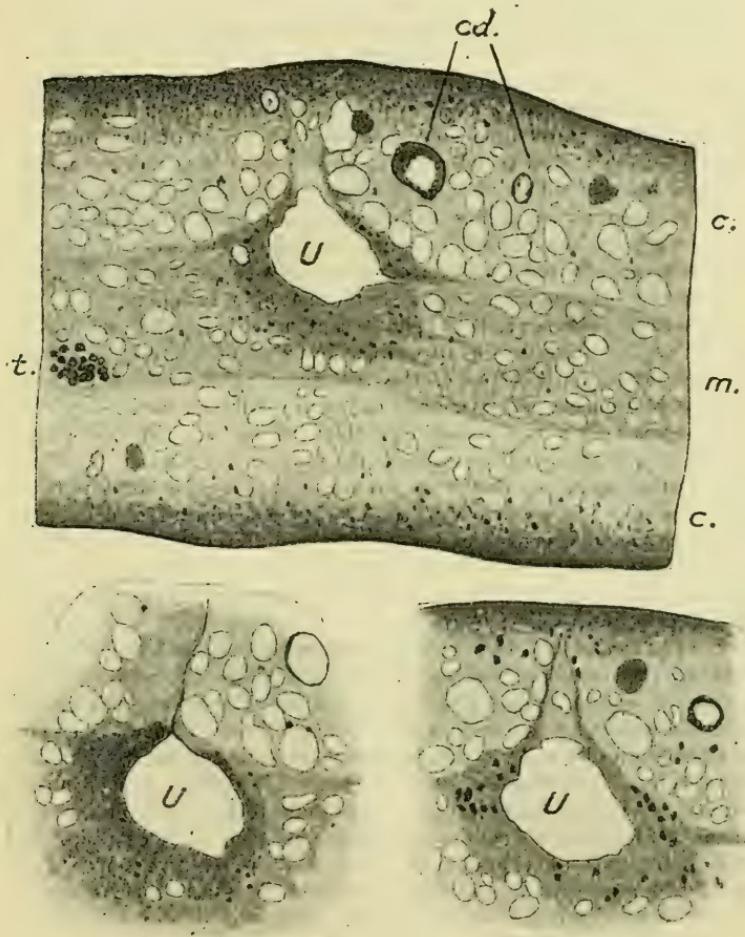
In more mature segments (see text-fig. 34) the layer of muscular fibres lying between the cortical and medullary regions is not at all defined in transverse section. Instead of a clear cut row of fibres, a denser layer of parenchyma seems alone to divide the cortical and medullary regions. In longitudinal sections, however, this dense layer is seen to be traversed by delicate longitudinal fibres one or two deep ; these are not apparent at all in transverse sections unless the latter happen to be cut rather obliquely, in which case the fibres become visible. This difference between the longitudinal muscular layer in

* "Zoological Results . . . from New Britain, New Guinea, etc.," by Arthur Willey, Cambridge, pt. v. 1900, pl. lv. fig. 18.

† P. Z. S. loc. cit.

various regions of the body of *Ichthyotania gabonica* is not at all due to the differences in the mode of preservation and staining. The pieces of worm from which the various sections described above were cut had been treated in precisely the same manner.

Text-fig. 34.



A series of sections of *Ichthyotenia gabonica* to show rudimentary uterine pores.

c. Cortical layer. c.d. Calcareous bodies. m. Medulla. t. Testis.
u. Uterus.

The *medullary parenchyma* also changes its character in different regions of the body. Anteriorly it is dense throughout; later the cortical region is composed of a lax parenchyma while the

medullary parenchyma is more dense. In the fully mature segments towards the end of the body both the cortical and the medullary parenchyma are equally lax in structure. This renders it very difficult to follow the excretory tubes the calibre of which is not greater than that of the spaces between the fibres of the parenchyma.

This species also contrasts with some others (as is shown in text-figs. 33 & 34) in the large and very conspicuous calcareous corpuscles.

The testes are numerous and show the usual arrangement met with in this genus. In ripe segments I counted as many as ten testes in one transverse row, five on either side of the median uterus. It appeared to me that in this species the entire generative system was ripe at the same time. That is to say, the testes were mature in segments in which the uterus was filled with eggs; and, on the contrary, more anteriorly, where the uterus was only represented by a slender median cord, in which a lumen was hardly discernible, the testes were also immature. They are at first represented by patches of nuclei in the medullary parenchyma. Later they are in the form of sharply marked cavities, loosely packed with the testicular cells, and when fully mature the masses of spermatozoa nearly fill the cavities. The sperm-duct forms the usual coil close to its opening into the cirrus-sac. This coil appeared to me to be denser than in some other species, and the lumen of the sperm-duct not to be quite so wide as is often the case. The coil of the sperm-duct and the cirrus-sac together occupy from one-third to one-half of the diameter of a proglottid, and lie at about its middle, sometimes rather anterior, at times rather posterior, to the middle line.

The cirrus-sac is, as a rule, almost spherical in shape in the mature proglottids. Its walls are thin. The cirrus itself lies coiled up within it, and not much room is left between the cirrus and the walls of the sac in which it lies. Everywhere the cirrus is surrounded by a layer of glandular cells like those to which I have referred in *Ophidotaenia naiae**. When the cirrus-sac is examined in an entire proglottid mounted in glycerine, the anterior and outside region of the sac is seen to be occupied by the distal part of the cirrus, which is of much greater calibre than the rest and lies almost straight. The rest of the sac is occupied by the close coils of the narrower region of the cirrus. In such preparations the cirrus is of a golden yellow colour, and thus stands out conspicuously from the rest of the tissues of the worm. I have never observed the cirrus in a state of protrusion; but, on the other hand, I have seen the whole sac itself partially protruded in a way commented upon by Schwarz† in other species of this genus. I found no spines upon the cirrus anywhere. The vagina runs at first straight and parallel with

* P. Z. S. 1913, p. 29.

† "Ichthyotænien d. Reptilien," Inaug.-Diss. Basel, 1908.

the cirrus-sac; in this region it is wider than posteriorly. It then bends towards the median line of the segment and passes straight down the middle line until near to the ovary. The rest of the vagina, both in front of and behind the ovary, forms a close coil. I did not find any conspicuous shell-gland; but the "Schluckapparat" was quite conspicuous. The absence of the shell-gland, or at any rate its inconspicuous size if present, is to be accounted for, as it appears to me, by the structure of the uterus, to which attention will be called immediately. The ovary of *Ichthyotænia gabonica* is a single organ, the two wings being continuous with each other across the median line. The ovary is flat and lies on the ventral side of the body, touching the border-line between the cortical and medullary parenchyma. It extends to near to the lateral boundary of the medullary layer. The vitelline glands show no peculiarities, and are as usual lateral.

The uterus, however, is in some ways remarkable. When immature it is a solid rod running throughout the body. This is soon excavated, and even in ripe segments parts of the uterus are still simply a narrow tube, while elsewhere it is dilated and full of eggs. In the most fully mature segments which I have seen the uterus seems to fill the greater part of the medulla from side to side.

There are no very marked lateral diverticula of the uterus such as occur in other species of *Ichthyotænia*, and which are so very markedly differentiated from the median stem in my genus *Ophidotænia*. But there are here and there outgrowths on each side, which are shown in transverse sections of a ripe proglottid by a trabecula dividing the cavity of the uterus. The walls of the uterus where it is narrow, and as a rule though not invariably without any eggs, are thick and of glandular appearance. These walls are darkly staining and granular, and seem to consist of a glandular epithelium which very possibly secretes the shell of the egg. But it must be remarked that this layer of tissue is not like the numerous stalked glandular cells which form the cells of the diverticula of the uterus in *Ophidotænia naiae*. The drawing (text-fig. 34, p. 157) presents the appearance which is shown by the uterine walls of this species. Where the uterus is wider and full of embryos the walls are much thinner; but this appearance may be due simply to the stretching of those walls and not due to any difference of real structure. When the uterus is widened out it occupies the middle of the body and is in close contact with the boundary-line of the medullary and cortical regions above and below.

This is not, however, always the case: in some parts of the same proglottid the uterus extends further towards the outside of the body ventrally than dorsally. In sections of the uterine tube which have a narrower calibre it is plain that that tube occupies a ventral position. There is more medullary parenchyma above than below it. I have observed in such places a

state of affairs which is represented in text-fig. 34. It will be there seen that the uterus gives off a slight diverticulum towards the exterior of the body which is visible for at most three consecutive sections. This outgrowth, however, does not reach the exterior, for it is plugged with cortical tissue. But one can readily see in the sections, of which the drawings referred to are copies, that a denser fibrous layer surrounding the uterus is prolonged towards the exterior, in the same fashion as, but further than, the uterine cavity. This peculiarity seems to me to be explicable on the hypothesis that we have here either a vestige of, or the beginning of, separate uterine pores such as exist in the undoubtedly closely allied, if not identical, genus *Ophidotænia*. I am, however, convinced that there are not in the present species any actual pores.

The uterus in the ripest proglottids is very full of eggs which have a narrower and thicker outer shell and a wider and thinner inner shell. There are no external processes such as Schwarz has figured in *Ichthyotænia nattereri**. The eggs are not in any way massed into balls such as occurs in the allied genus *Acanthotænia*†; they lie, as it were, anyhow, but with some granular material between them. This tends to aggregate them into a continuous mass.

I believe this species to be different from any that have been described. Its general size and the size of the scolex are perhaps nearest to those of "*Tænia*" *racemosa*, as described by Schwarz. But the material belonging to this latter species, which was examined by Schwarz, was not in a satisfactory state of preservation. And, moreover, *Ichthyotænia racemosa* seems to frequent South American snakes, while that which forms the subject of the present communication is African in range. Moreover, the cirrus is unlike that of my species in not being coiled and only pursuing an undulating course through the cirrus-sac. The testes in *I. gabonica* do not appear to be so large as those of *I. racemosa*. Nor are the diverticula of the uterus so well marked as in *I. racemosa*.

Ophidotænia russelli, sp. n.

Of this species an example was obtained from a Russell's Viper (*Vipera russelli*) in June 1911. The general appearance of the worm is that of a typical *Ichthyotænia* or *Ophidotænia*, which genera do not differ to the naked eye unless it be ultimately proved that a small scolex characterises *Ophidotænia* and a large, or at any rate larger, scolex characterises *Ichthyotænia*. The worm was very active when alive, and the specimen when extended was a foot or so in length. The scolex, as already mentioned, is very small and not more than one-half of the width of that of *Ichthyotænia gabonica* just described. It is of

* *Loc. cit.* Taf. iii, fig. 7.

† Beddard, P. Z. S. 1913, text-figs. 6, 7, p. 20.

course unarmed. The neck is long. The posterior proglottids are longer than broad and from 2–3 mm. wide. The generative pores alternate, but there are often as many as four or so consecutively on one side. The external anatomy of this species indeed hardly differs from that of *Ophidotenia naiae*, for which I have recently founded the genus *Ophidotenia**.

The internal structure, too, is very similar. In transverse sections the calcareous bodies are by no means so plain as in *Ichthyotenia gabonica* just described. But in pieces of the body mounted entire in glycerine the calcareous corpuscles are quite obvious, and appear to be restricted to the lateral regions of the segments, being absent or very few in the median dorsal and ventral regions. It appeared to me that the glandular subcuticular layer of the present *Ophidotenia* does not consist of such large cells as that of the other species of the genus. But the arrangement of the longitudinal muscles was quite similar. It is possible that the existence of the strong internal longitudinal fibres in *Ophidotenia* in the sexual proglottids and their very feeble development in *Ichthyotenia gabonica*, may prove to be a generic distinction between these types.

I could find in this worm only a single water-vascular trunk on each side of the body. In this the two species of *Ophidotenia* (if there be two) agree; but there is a small difference to be observed which helps to justify a separation.

In the present species the water-vascular tube lies further away (towards the centre of the proglottid) from the vitelline strip than in *Ophidotenia naiae*. And this difference is even greater than appears by a mere inspection; for the transverse diameter of the sections of *Ophidotenia naiae* was greater than that of those of *Ophidotenia russelli*. In the latter species I observed two and a half to three ripe testes to lie between the water-vascular tube and the vitelline strip, whereas there was only room for one or a little more in *Ophidotenia naiae*.

The reproductive organs also show some slight difference in the present species from what I have observed in its congener. The testes are quite absent from the middle of the proglottids, and are laterally pressed up close to the strip of vitelline glands. They seem to me to extend further towards the middle line in *Ophidotenia naiae*. The cirrus-sac and the coil of the vas deferens together reach to nearly the middle of the segment. The cirrus is not by any means long and the coil within the cirrus-sac is disposed in one or two loops only, thus contrasting with that of *Ichthyotenia gabonica* described above. It appears to me that the coiled region of the male duct lying within the cirrus-sac in *Ophidotenia naiae* was rather larger than in the present species. There is no doubt that the cirrus-sac is larger in the first-named species. In any case, the small number of the coils lying within the cirrus-sac of the present species contrasts very markedly with

* P. Z. S. 1913, p. 25.

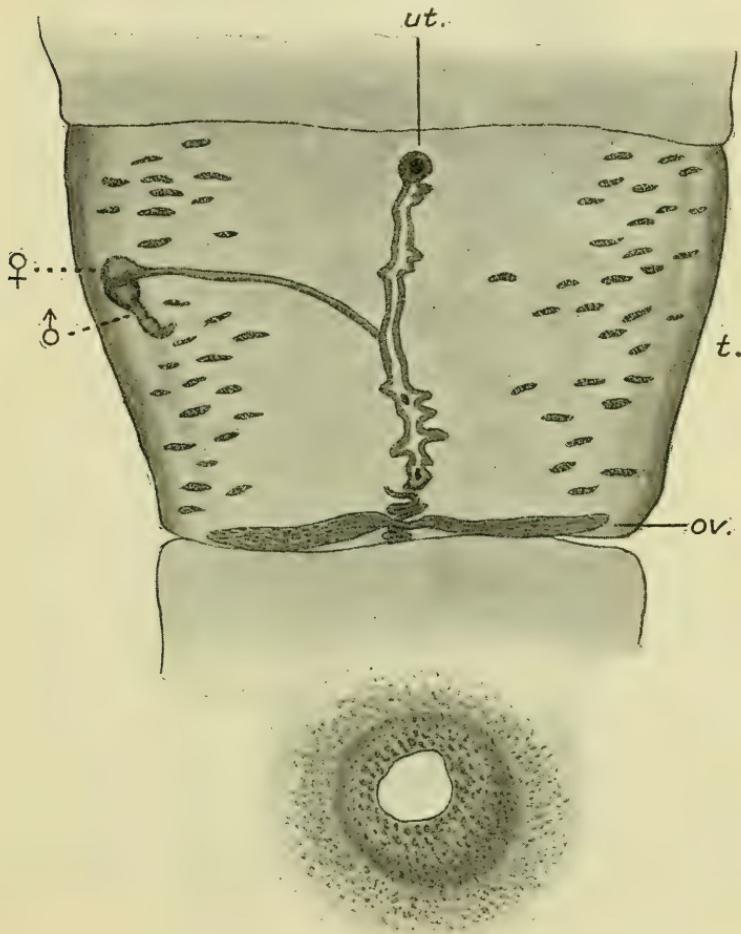
what I have observed in *Ichthyotenia gabonica*, and glycerine preparations of the proglottids of the two species are very easy to distinguish. There are no special comments to make concerning the ovary and the female ducts in the neighbourhood of the ovary; they appear to agree entirely with those of *Ophidotenia naiae*. The oviduct widens to form the end of the vagina, and the latter suddenly dilates at its external orifice to form a muscular sac quite as large at the terminal section of the cirrus. It is nearly always in front of the opening of the cirrus; I found it posterior only in one case. I could not find a definite sphincter muscle surrounding the terminal section of the vagina, such as exists in *Ophidotenia naiae*. The preparations that I have made of the present species which illustrate the structure of the uterus, serve rather to increase our knowledge of this organ in the genus *Ophidotenia* than to accentuate differences between the two species of the genus.

The accompanying drawing (text-fig. 35) shows the uterus in an incompletely mature proglottid, which is therefore not very long in proportion to its breadth. The uterus seems to lie exactly in the middle line and to extend from near the posterior to near the anterior border of the proglottid. In this young proglottid the lateral diverticula of the median stem of the uterus were only just beginning as inconspicuous buds. At the anterior end the uterus opens directly on to the exterior by a large and very conspicuous pore, which can be easily seen by careful focussing to have clear-cut outlines due to the cuticle. It is quite circular in contour. It is a noteworthy fact to find one definite uterine pore only. For the fact brings the peculiarities of this genus *Ophidotenia* more into line with the Bothrioccephalids and tends to show that, as might be expected, the frequent pores of later stages are a secondary state of affairs, and thus not inimical to the main point of resemblance urged between this genus and the lower tapeworms. But, although there is only one large definite external uterine pore to be seen in this preparation, the subsidiary pores, much smaller, are to some extent recognisable prolongations of the uterus approaching to very near the surface, if not actually opening on to it.

In the proglottid in front of and in that behind the one which is figured in the annexed drawing and has just been described, there is not a large anteriorly situated uterine pore. But a few rather indistinct pores are visible, like the subsidiary ones noticed in the case of the first proglottid to be examined. The indistinctness of these pores leads me to infer that they can be temporarily closed and, perhaps, indeed they may become permanently closed, thus approximating to the conditions that I have described above in *Ichthyotenia gabonica*. I have naturally examined these pores in transverse sections. In such sections a depression in the outer layer of the body which forms the external part of the uterine pore is conspicuous and relatively large. Nearer to the centre of such a depression the cuticle is seen to

cease rather rapidly, leaving an obvious discontinuity. As I have pointed out in *Ophidotaenia naiae*, there is in the present species no question of an artificial rupture of the cuticle due to

Text-fig. 35.



The upper figure represents an incompletely mature proglottid of *Ophidotaenia russelli*.

The lower figure is of the anterior uterine pore more highly magnified.

ov. Ovary. *t.* Testes. *ut.* Uterus, the external orifices of which are represented black. *♂ & ♀.* Male and female terminal organs.

an accident in the processes of section cutting. The cuticle is seen to become thinned to a point on both sides of such an orifice

viewed in transverse section. But the break in the tissues beneath the cuticle was not in my sections coextensive with the area of this pore.

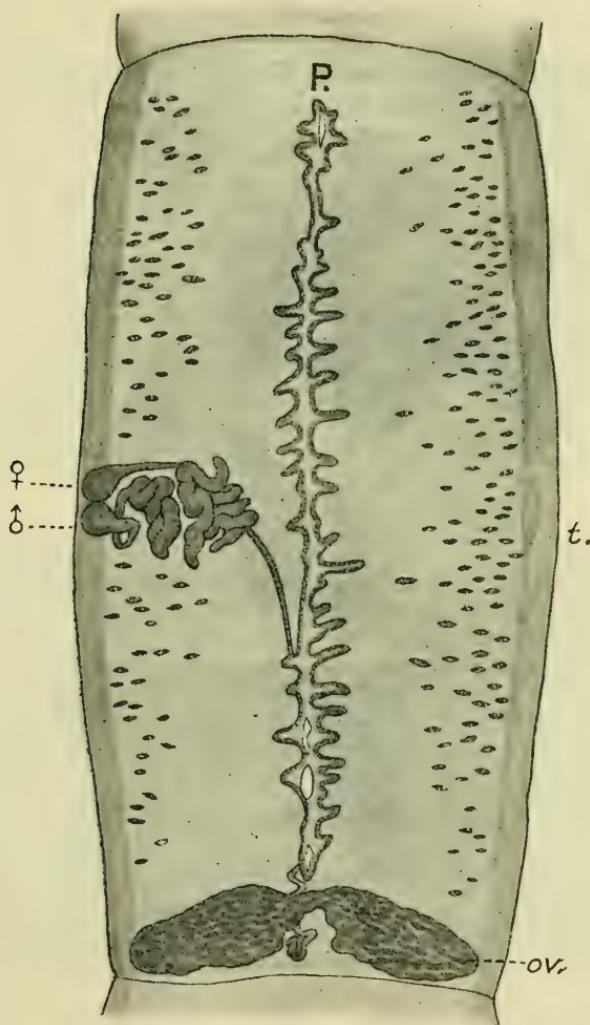
In such sections the area of the body upon which the pores lie does not appear to be raised above the general surface of the body. But in the large terminal orifice of the uterus which I have depicted in text-fig. 35, the uterine pore is clearly borne upon the summit of an elevation. I have already pointed out that this orifice is circular in outline, and it may be added that the underlying soft tissues correspond to this, the discontinuity corresponding with that of the cuticle I have just mentioned ; and there is here an apparent contradiction—that in my transverse sections there is no such correspondence between the areas of the cuticular pores and the narrow canals leading thereto from the uterus. This apparent contradiction will be reconciled by a consideration of text-fig. 36, which represents an older proglottid than that illustrated in text-fig. 35. It is considerably longer in proportion to its breadth, and the coils of the vas deferens gorged with sperm are plainly visible, which is not the case in the shorter proglottid. Furthermore, the ovary has gained greatly in bulk, as will be noticed in a comparison of the two figures. Differences in the structure of the uterus I shall refer to later.

It will be observed that the external uterine pores are quite obvious on this superficial view, but that the orifices are not always circular as has been described in the younger proglottid. The preparation from which text-fig. 36 was drawn consisted of three proglottids. In all of them there was an uterine pore coinciding with the anterior termination of the uterus. The pore was not circular but of an elongated oval form, and other slit-like forms were observed behind this point. It follows, therefore, that in transverse sections a given pore will occupy a considerable number of individual sections of the series. As to the structure of the uterus itself, it will be seen that the lateral diverticula have grown in length as compared with the younger stage. They are apt to be irregular in position, not being always symmetrically paired ; indeed, the diverticula are sometimes lacking for a considerable distance on one side of the median stem. The stalked glandular cells covering the diverticula agree with those of *Ophidotænia naiae*.

Ichthyotænia sp.?

Of this species a number of examples were obtained from the Moccasin Water Viper (*Ancistrodon piscivorus*). The living worms reached 14 inches in length and they measured 8 to 10 inches when in spirit. The unarmed suckers were quite mobile and independent of each other. The neck region can contract and move like the whole body. The scolex is large and measures in the contracted state 2 mm. in width or even rather more.

Text-fig. 36.

Ripe proglottid of *Ophidotaenia russelli*.

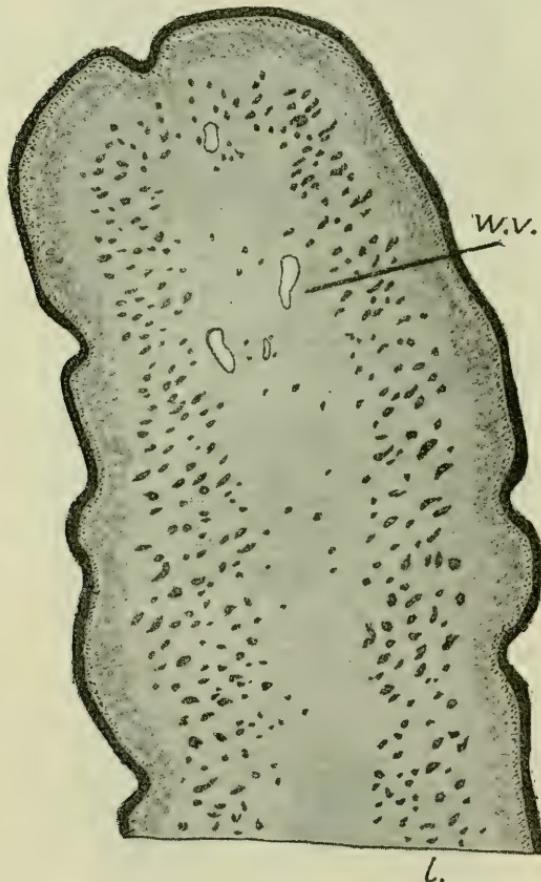
P. Anterior uterine pore.

Towards posterior end of uterus three other uterine pores, also left white, are seen.
Lettering as in text-fig. 35.

I am disposed, on account of the external characters of this worm, to regard it as in all probability identical with *Ichthyotenia*

marenzelleri described by Barrois *, and later by Schwarz †, which was obtained by Calmette from the same species of snake ‡. But, inasmuch as there were only just indications of the reproductive organs I am unable to write positively upon the matter, and thus

Text-fig. 37.

Transverse section through neck-region of *Ichthyotenia* sp.

l. Longitudinal muscles. *w.v.* Water-vascular tubes.

prefer not to give it a name. It is rather remarkable that in proglottids situated 8 inches or so from the scolex, there were merely traces of the reproductive organs—in fact, only the

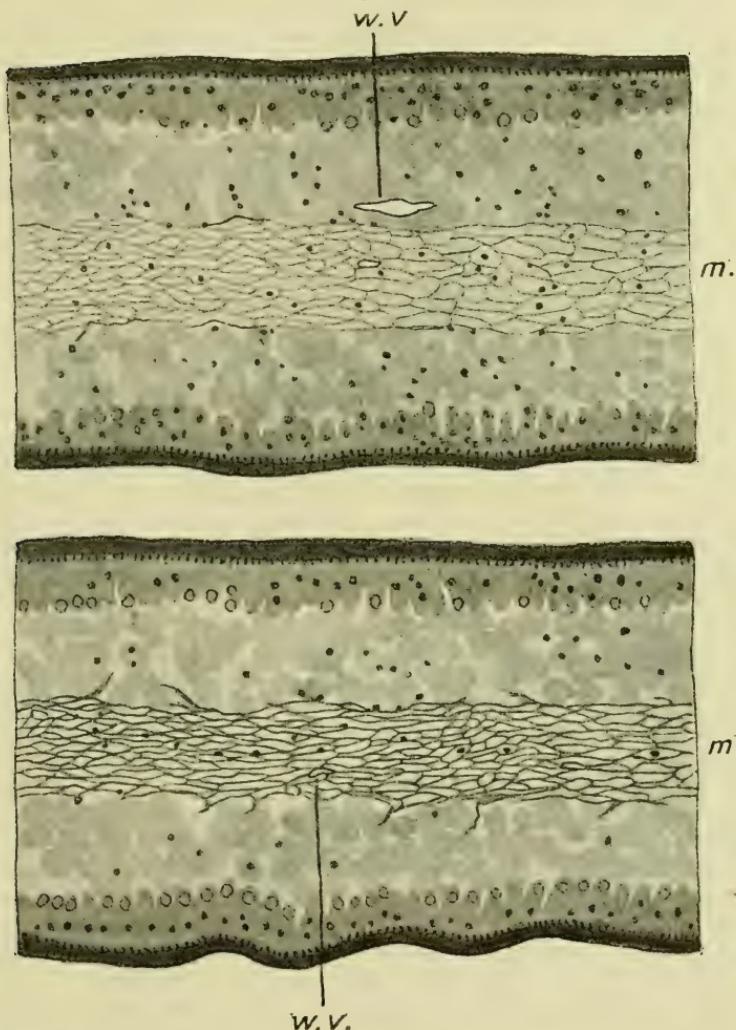
* Bull. Soc. Sci. Agr. Lille, 1898.

† "Die Ichthyotenen der Reptilien," etc., Inaug.-Diss. Univ. Basel, 1898.

‡ "*Trigonocephalus piscivorus* (*Erigonoccephalus piscivorus*)."

beginning of the formation of the ducts passing between the two water-vascular tubes.

Text-fig. 38.



Transverse sections through portions of proglottids of *Ichthyotænia* sp.
m. Medulla. w.v. Water-vascular tubes.

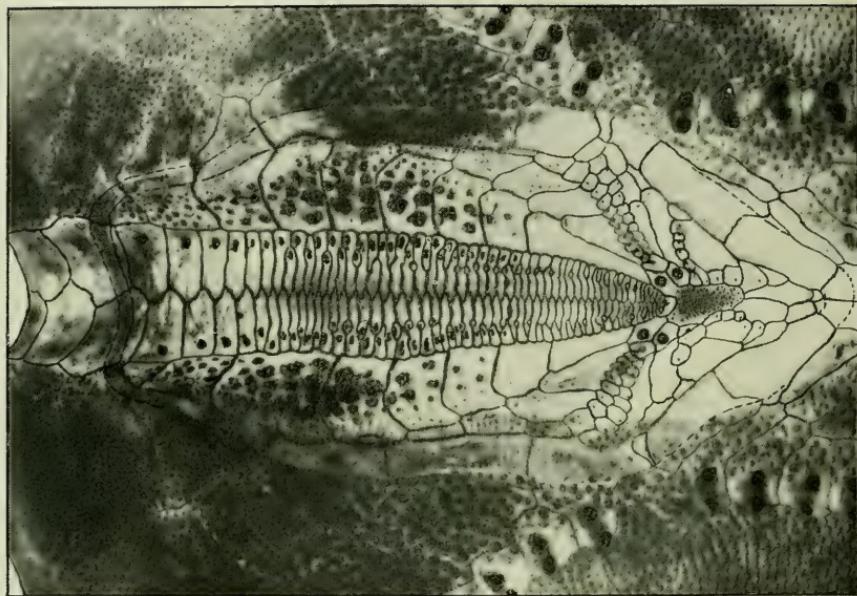
I have, however, a few remarks to add to Schwarz's description of this worm. This author does not mention the fact that the neck region, at any rate just behind the scolex, is provided with a very thick layer of longitudinal muscle fibres occupying the whole of the space between the subcuticular layer and the medullary

parenchyma. The number of fibres in a single vertical row was about 12; and they were not associated into bundles. The individual fibres were, indeed, rather far apart. The section illustrating the structure of this region of the body is represented in text-fig. 37, and it also shows that the medullary region is to a slight extent invaded by these longitudinal fibres. It will be observed that we can detect in this species of *Ichthyotænia* an arrangement of the muscular system like that of the Ichthyotæniids of *Varanus*, which I follow v. Linstow in assigning to a separate genus *Acanthotænia**. The resemblance, however, is not exact; for in *Acanthotænia* the fibres are associated into definite bundles, which is as definitely not the case in the present species. Still there is a likeness which so far weakens the case for the generic distinctness of *Acanthotænia*. And, furthermore, I can find in the *Ichthyotænia* under consideration no marked layer of longitudinal fibres in the body generally, such as is obvious, for example, in *Ophidotænia russelli* described above. Indeed, Schwarz, remarks that "die innere Längsmuskulatur ist schwach." I do not assert that there may not be some delicate fibres here; but there is nothing so conspicuous as is to be met with in many other forms. The musculature therefore in this region of the body agrees with that of *Acanthotænia*; but there is no spiny covering of the scolex. Schwarz has remarked upon the presence in *I. marenzelleri*, as well as in *I. calmettei*, of transverse muscular fibres occupying the whole of the medullary layer. I cannot interpret the appearance of the transverse sections of the present species in that fashion.

The accompanying drawings (text-fig. 38, p. 167) show two sections of this species, of which the upper one is from a region of the body anterior to the lower one. It will be seen that in both the medullary parenchyma differs from that of *Ichthyotænia gabonica* figured above† by the more strongly marked fibrous looking network in the meshes of which the homogeneous ground substance lies. Furthermore, it seemed to me that this network was considerably more emphasized in the posterior region of the body than in the more anterior segments. In the posterior region, moreover, I did not always detect the water-vascular tubes, which are quite easy to see more anteriorly as is to be gathered from an inspection of the figure to which I have referred. The difficulty of seeing these tubes is further evidence of the greater thickness of the network in the more posteriorly situated proglottids. Whether muscular fibres lie in this network I have not been able to see; but I am of opinion that the network is not a transverse muscular layer, but merely an exaggeration of the network which is always visible in this situation in these and other tapeworms, and in which may lie muscular fibres independent from it. I have already directed attention to the presence of such muscular fibres in *Ichthyotænia gabonica* described above.

* P. Z. S. 1913, p. 5.

† *Supra*, p. 155, text-fig. 33.



2.



1.

ECHINOCARDIUM CORDATUM.

13. The Anterior Ambulacrum of *Echinocardium cordatum* Penn., and the Origin of Compound Plates in Echinoids. By HERBERT L. HAWKINS, M.Sc., F.G.S., Lecturer in Geology, University College, Reading.*

[Received November 8, 1912 : Read February 4, 1913.]

(Plate XXVI.† and Text-figures 39–41.)

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I. *Introduction.*

During the course of research into the anatomy of the test of the primitive Irregular Echinoids, I had occasion to re-examine the corresponding structures in living forms, and naturally included among these the common British "Heart-Urchin," *Echinocardium cordatum* Penn. It might have been thought that, in the case of a species so long known and so frequently examined, all the essential structural features had been determined. It was with considerable surprise, therefore, that I found in it a character (from my point of view of first-rate importance) that has not hitherto been certainly recognised, and never adequately figured or described.

Lovén, with his customary fidelity, indicated some of the complexity in ambulacrum III. of the species (*Études sur les Échinoïdées*, Pl. xii. fig. 107, and Pl. xxxix. fig. 222), but he gave no comment on the structure, and his drawings of it are incomplete. Beyond this casual recognition, I have been unable to find any account or figure of the very remarkable features here described, and, indeed, most of the descriptions and drawings of the area that I have seen are positively misleading. This is undoubtedly due to the fact that a surface examination, however careful, shows little or no trace of the elaborate structure present. It was not until I accidentally discovered a new method of displaying sutures that I had any suspicion of the remarkable character of the area.

The examination of some 150 prepared specimens of various sizes has led to considerations which have an important bearing on the question of the origin of "plate-crushing," and a discussion

* Communicated by Dr. F. A. BATHER, F.R.S., F.Z.S.

† For explanation of the Plate see p. 181.

of the various views held on that point follows the description of the anterior ambulacrum of *E. cordatum*.

II. *Technique.*

The test in ambulacrum III. of *E. cordatum* is exceedingly thin, even in large examples being only as thick as ordinary paper. Viewed from the outside, the area between the apical system and the anterior border of the internal fasciole is covered with an almost uniform granulation, and no trace of sutures can be distinguished in the adapical part. From the inside a clue can be obtained as to the existence of complexity in the structure of the area, but it seems a general rule among Echinoids that the sutures shown on the inner surface of the test differ to some degree in their disposition from those on the outside. After a great number of experiments, I have perfected a method whereby, as may be judged from Pl. XXVI. fig. 2, the details of the sutures, however minute, may be rendered clear.

The specimen should be well dried, and may have been stored in a collection for many years without lessening the efficacy of the process. It should not, however, be macerated, and the bleached specimens of *E. cordatum* often found on sand-dunes rarely prove suitable material.

When the specimen is quite dry and brittle, the test should be split open along the ambitus, and all the sandy and organic contents removed. Especial care is needed to remove all the dried-up ampullæ of the area to be examined. It is usually necessary to moisten the specimen for this purpose. When all the radioles and accessible organic matter have been brushed away from both surfaces, the specimen should be thoroughly dried again. A hurried drying at this stage (over a flame or near a fire) gives the best results.

The part to be examined is then saturated with a staining solution. Of all the fluids that I have used, none give clearer results than the aniline colours supplied as cheap ink at a penny per bottle. The red, blue, and green colours are all equally effective, but I prefer to use the last-named, as being more restful to the eyes, and admirably suited to the requirements of photography. It is advisable to apply the stain with a fine camel's-hair brush to both the inner and outer surfaces, and the test should be quite saturated.

When the area is again perfectly dry, the brush should be dipped into strong hydrochloric acid, and drawn lightly once or twice over the outer surface. Care must, of course, be taken to wash off all the acid (from both surfaces) very quickly. The etching with acid should be continued until the sutures stand out clearly. The process depends on the fact that a thin film of organic matter exists between the plates, so that, when the calcareous substance is partly etched away, the densely stained tissue in the sutures remains standing out in relief.

The acid has no apparent effect on the green dye, and the results show no serious sign of fading or other degeneration after three years. (The specimen should not be kept for too long exposed to bright sunlight.) Although the process sounds somewhat involved, it can be very quickly accomplished. I have completely prepared fifty specimens within two hours of their having been cleaned. The method will probably be found useful for distinguishing sutures in other Echinoids, but I have not obtained such clear results when applying it to thick plates, such as those of *Echinus*. For the guidance of any who may adopt the method I add the following particulars:—

It is inadvisable to reverse the order of procedure outlined above—staining should always precede etching.

The process destroys the finer surface characters of the plates, and should not be used on rare specimens.

The etching should be continued until the plate surfaces are almost colourless, but care must be taken that the plates are not eaten through, or distortion of the sutures will result.

The clearness of the preparation may be increased by slightly etching the inner surface.

The sutures should be viewed by reflected light, and will not show in perfection unless the specimen is dry.

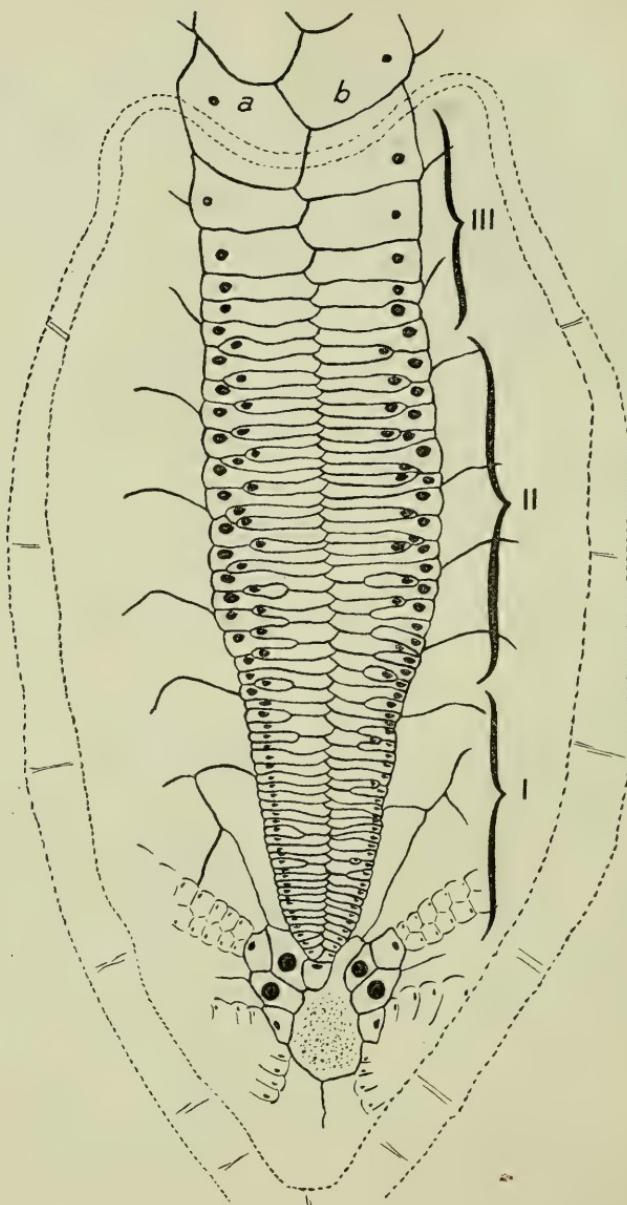
If the staining has not been sufficiently intense, but little advantage is gained by applying more. The specimen may often be made useful, however, by saturation with glycerine and examination by transmitted light.

III. Description of ambulacrum III. of *Echinocardium cordatum*.

The part of the ambulacrum here considered is enclosed by the internal fasciole. In *E. cordatum* this region is depressed to form a considerable groove passing into the anterior notch. The surface of the area is covered with a uniformly fine granulation, which tends to become more sparse along the perradial suture in the anterior part. A few very small tubercles are sometimes developed on it, although some of the largest tubercles on the test occur on the sides of the groove, which are built of interambulacral plates. The shape of the groove (and also of the fasciole) is rarely symmetrical, being normally expanded more on the right side than on the left.

The character of the pores is strikingly different in various parts of the area:—(i.) Near the apical system the pores are minute, and usually uniserial in arrangement. (ii.) In the middle section they are much larger, more or less pyriform or transversely elongated in shape, and arranged in a very complex order, biserially, triserially, or irregularly. They often form broad “poriferous zones” that occupy half the width of each half of the ambulacrum. (The area in this section expands to its greatest width.) It is here that the longest podia are situated. In both the foregoing sections the pores are closely packed.

Text-fig. 39.

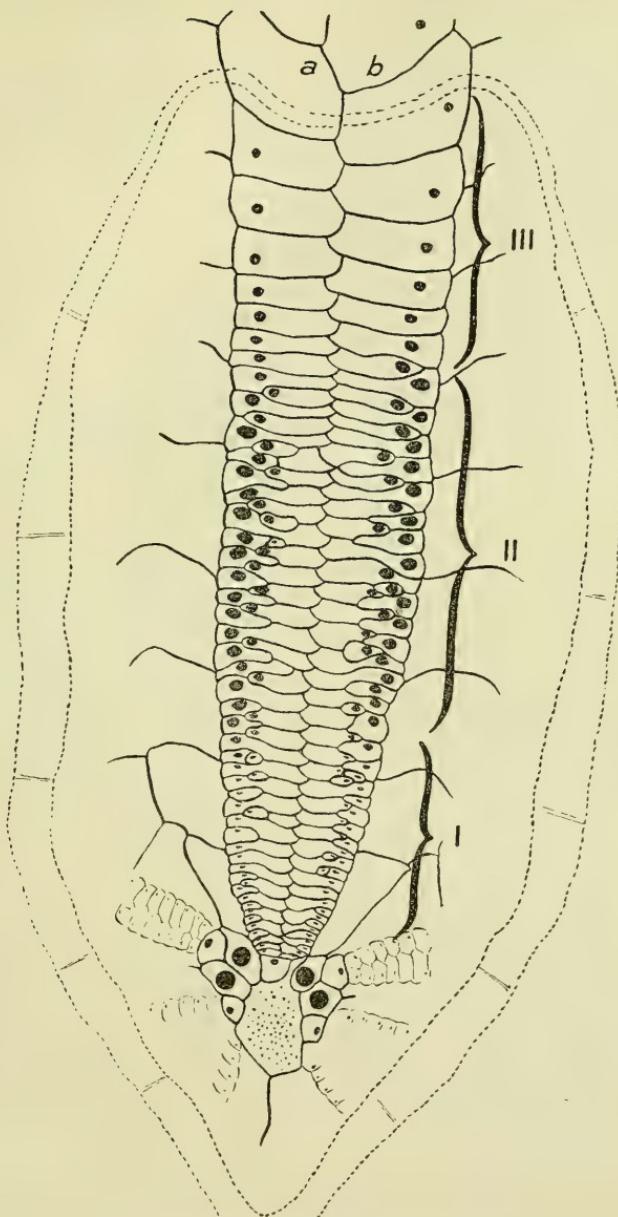


Ambulacrum III. of *Echinocardium cordatum*, with considerable lateral expansion.

There are 67 ambulacrals in column *a*, and 69 in column *b*.

In both columns 45 plates remain primaries.

Text-fig. 40.



Ambulacrum III. of *E. cordatum*, with slight lateral expansion.

There are 69 ambulacrals in each column.

In column *a* 29 plates, and in column *b* 27 plates, remain primaries.

(iii.) Finally, the pores become almost circular in shape and well spaced out anteriorly, progressively decreasing in size until the fasciole is reached.

No sutures can be seen on the outer surface of the test in the two adapical sections of the area, but some indication of them, resulting from the inflation of the plates, can be seen from within. By applying the method above described, they can be rendered clearly visible from the outer view, and the following features become manifest.

"Plate-crushing" is restricted to sections i. and ii. of the area. In those sections the plates are very low, especially in i. and the anterior part of ii. In iii. they rapidly increase in height.

In section i. there is usually a large preponderance of primary plates, and the type of "plate-crushing" found is that characteristic of most Echinoids, namely, the production of demi-plates (in contact with the adradial, but not reaching the perradial, suture). The demi-plates are developed quite irregularly.

In section ii., where the ambulacrum attains its greatest width, the structure is far more complex. The plates in some parts become very low, often being mere strips of calcite. Demi-plates, occluded plates (in contact with the perradial, but not reaching the adradial suture), and even "klasma"-plates (not reaching either vertical suture) are developed, and a consequent displacement of the pores occurs. In some rare instances the pores have atrophied in occluded plates. The anterior part of this section is built of relatively high plates, and the pores are of very large size. The "plate-crushing" here results in the formation of occluded plates, which, however, almost reach the adradial suture.

In all of the specimens (over 150) examined, individual peculiarities and irregularities, though frequent, are insufficient to mask the general pattern. The differences met with seem, moreover, to conform to two general conditions. These can be roughly indicated as being (a) the relative width of the area, and (b) the length of the area affected, measured in proportion to the size of the specimen.

(a) There is a great variation in the degree of lateral expansion attained by the ambulacrum in its middle section. This character has no connection with different age, as specimens of practically the same size may show the extremes of difference. It seems an invariable rule that in the narrower areas the development of occluded and "klasma"-plates is greater than in the broader ones. A comparison of text-figs. 39 and 40 will make this clear. The development of these small plates can thus be ascribed directly to lateral compression.

(b) Individuals of the same size have approximately the same number of ambulacrals (about 69 in large specimens) between ocular III. and the fasciole. The fasciole crosses the ambulacrum from the 8th or 9th interambulacral plates on each side irrespective of the size of the specimen. The position of the apical system is variable, being sometimes almost central, and at others

considerably to the front of the centre. This results in a corresponding length or shortness of the part of the ambulacrum within the fasciole, although the number of plates present is the same in both cases. In the shorter areas, the degree of crushing, as indicated by the development of demi- and occluded plates, is relatively increased. This result is obviously brought about by the greater vertical compression in the area.

For the originals of text-figs. 39 and 40 I have selected specimens of almost exactly the same size. There are the same number of ambulacrals in both in the part of the area considered, but their characters show the two extremes of difference. (Both figures are drawn to the same scale directly from photographs in an enlarging lantern.) Text fig. 39 represents a laterally-expanded area, in which sections i. and ii. occupy most of the length up to the fasciole. Text-fig. 40 represents a comparatively narrow area, in which section iii. occupies almost a quarter of the region within the fasciole. It will be noticed that the degree of plate-crushing is far greater in text-fig. 40 than in text-fig. 39, more notably in the unexpanded adradial than in the perradial tracts.

IV. *The meaning of the Structure.*

The only other Spatangoid in which I have seen a similar structure to that just described is *Heteraster oblongus* from the Lower Cretaceous. In that form the pores of ambulacrum III. are more or less biserially arranged, and "plate-crushing," never approaching in intensity that of *E. cordatum*, is developed. I have been able to satisfy myself that no disturbance of the serial arrangement of the pores, and no trace of "plate-crushing," occur in *Echinocardium flavesiensis*. The same remark applies to the species of *Micraster* and *Hemiaster* that I have seen, but there are indications of some irregularity in the anterior ambulacrum of a *Schizaster* from the London Clay in my collection.

Now in *Heteraster*, *Schizaster*, and *Echinocardium cordatum*, ambulacrum III. is situated in a fairly deep groove; while in *E. flavesiensis*, *Micraster*, and *Hemiaster* the area is more or less flush with the surrounding test-surface in the adapical part. This seems to indicate some connection between the presence of an anterior sulcus and "plate-crushing" in the anterior ambulacrum. I recently (P. Z. S. 1912, p. 464) argued that the sulcus below the anus in many Jurassic Nucleolitidae might be ascribed to an excessive growth of the plates there as a result of the interference of the periproct. The same explanation seems to suffice in this case. The number of interambulacral plates bordering on ambulacrum III. in *E. cordatum* remains constant during all the later growth-stages, but the number of ambulacrals increases steadily with the growing size of the individual. This indicates a proportionate increase in the potential length and expanse of the ambulacrum compared with that of the surrounding part of the test. That would result in a sagging inwards of the over-

developed region. A further support to this view is found in the fact that in very young specimens of *E. cordatum* (where "plate-crushing" is very slightly developed), the anterior groove is scarcely perceptible.

It appears, then, that after an early stage, the development of new coronal plates from the oculars in *E. cordatum* is arrested, save in the case of ocular III., where the issuing ambulacrum is continually growing by the addition of new plates. The rest of the test grows by the increase in size of the plates already developed. Little or no resorption of coronal plates occurs in Spatangids, and ambulacrum III. of *E. cordatum* is no exception to the rule. Indeed, the influence of the continuous growth of the area seems confined by the anterior part of the internal fasciole. In consequence, all the re-adjustment due to the continuous growth of new plates has to be carried on in the "petaloid" region of the area. The results are: firstly, an inward sagging of that part of the ambulacrum to form the anterior sulcus, and secondly, mutual resorption and rearrangement of the plates, causing "plate-crushing." The additional feature enters, as described above, that when the area is expanded laterally the intensity of the "plate-crushing" is proportionately reduced.

The physiological advantages of the character of the area in *E. cordatum* are obvious. A far greater number of podial pores can be compressed into the short space available than would be possible by other means, and this results in a greater number of prehensile podia being developed. Again, the absence of the complexity in *E. flavescens* seems explicable on the grounds of habitat. *E. flavescens* does not occur between tide-marks, and seems to be rarely, if ever, deeply buried in the sand, but *E. cordatum* is often more than six inches from the surface, and must therefore find greater difficulty in collecting food. Hence the development of a larger number of podia in the latter species.

The present paper is concerned more with the origin and development of the structure than with its physiological meaning, and I pass to a consideration of the views that have been expressed to explain "plate-crushing" in other groups of Echinoids.

V. Previous views on "Plate-crushing."

Most of the work that has been done on ambulacleral structures has had reference to the Regular Echinoids, among which the various characters have been largely used for purposes of classification since the publication of Duncan's paper in 1885 (Quart. Journ. Geol. Soc. vol. xli, pp. 419-452). Duncan expressed the view that "growth-pressure" was the cause of "plate-crushing," and he included as a subsidiary cause of the pressure the growth of tubercles on the plates. Many of his figures, however, show that the sutures separating the elements of a compound plate

pass across the boss of a tubercle without appreciable deflection. Lovén (*Études*) expressed a similar view to that of Duncan.

A. Agassiz (*Revision of the Echini*) stated that compound plates might be developed by the subdivision of original primaries, but no other author seems to have accepted this view.

Lambert, in 1892 (*Bull. Soc. géol. France*, vol. xx. pp. 38–100), referred to plating-complexity, and ascribed it to the pressure of new plates, not mentioning any influence of tubercle-growth. But in 1900, the same author (*Bull. Soc. Sci. Yonne*, vol. liii. pt. 2, pp. 3–57) expressed the opinion that the chief cause of “plate-crushing” was to be found in the expansion of the tubercles, and that normal “growth-pressure” exerted but a secondary influence.

Both Duncan and Lambert considered, then, that ambulacrals “plate-crushing” had a dual origin, the former holding that the pressure of new plates was the main cause, the latter regarding tubercle-growth as the chief agent.

More recently, Bather (1909, ‘Triassic Echinoderms of Bakony’) has suggested that the oncoming of “plate-crushing” in the Diademoid (Centrechinoid) ambulacrum is to be correlated with the growth of the perignathic ambulacrals, which restrain the plates from passing freely to the peristome margin. This view is, in effect, a return to that of Duncan, that growth-pressure of new plates is the main cause of the development of compound ambulacrals. Jackson (1912, ‘Phylogeny of the Echini’) considers “growth-pressure” alone in his discussion of ambulacrals structures.

In considering the corresponding features among the Holoctypoida, I have lately taken the same view (*Geol. Mag.* 1910 & 1911), and, as the structures above described in *Echinocardium cordatum* seem to have a bearing on the problem, I propose to give a discussion of the subject.

VI. *The Origin of “Plate-crushing.”*

The ambulacra contain compound plates in all groups of Regular Echinoids except the Cidaroida. Excluding the highly specialised and aberrant Perischoechinoida, the Regular Echinoids may be separated into two sections, in one of which (the Cidaroida) resorption of old plates at the peristome takes place freely and continuously, so that the proportionate diameter of the peristome remains constant throughout growth; and in the other (the Centrechinoida) the resorption does not keep pace with the growth of the corona, so that the peristome of an adult is proportionately smaller than that of a young form. In all the Cidaroida, and almost all the Centrechinoida, the growth of new plates at the edge of the oculars is continuous and regular. Thus while the Cidaroid ambulacrals can pass freely down the full length of their area, those of the Centrechinoid are to some degree hindered. The result must obviously be a compression of the earlier ambulacrals against the obstacle (e. g., *Hemipedina*, and,

for the Holoctypoida, *Pygaster*). The fact that the compression first shows itself near the peristome is significant; for, to my mind, it strongly supports the view that it is to the transference of the chief perignathic structures from the interambulacra to the ambulacra that the structural differences between Cedaroids and Centrechinoids are to be traced. Gradually, both in ontogeny and phylogeny, the region of compression extends further from the point of its origin, until in many forms (e. g., *Echinus*) it reaches practically to the ocular margin.

From the opposite standpoint, it is true that in the Cedaroida alone the ambulacra support mere granules, while every stage of complexity among the Centrechinoida corresponds with a progressive development of large tubercles. And indeed, there is no direct evidence for either side to be derived from a study of Regular Echinoids, so closely do "plate-crushing" and tubercle-growth coincide in their appearance.

A study of the ambulacral structures of the Irregular Echinoids has, however, convinced me that the "growth-pressure" of new plates is, for them at least, the essential and original cause of "plate-crushing."

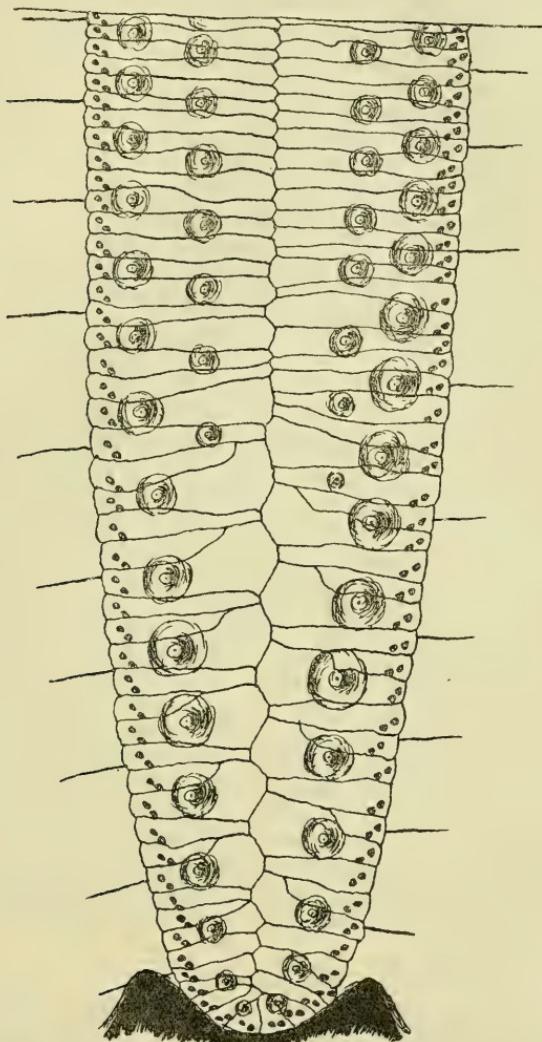
Among the Holoctypoida compound plates (on the Centrechinoid pattern) are developed to an ever-increasing degree as the group is traced from the Lias to the Chalk. With few exceptions, the amount of resorption of old plates at the peristome seems to decrease in corresponding order; and finally, the size, both relative and actual, of the tubercles steadily diminishes. In *Pygaster*, to take a typical genus, an interesting feature can be noticed in this connection. On the adoral surface the tubercles become large, and their areolæ often cross the sutures between the ambulacral plates. The very slight degree in which the development of the tubercles affects the arrangement of the plates can be estimated by an examination of text-fig. 41. The triple arrangement of the ambulacral plating of *Pygaster*, and presumably of the other Holoctypoida, must then owe its development to some more fundamental cause than that of tubercle-growth.

In many of the larger Clypeastroida (e. g., *Clypeaster*), the petaloid parts of the ambulacra are built up of alternate primaries and demi-plates. The tuberculation differs in no respect from that of the extra-petaloid regions of the test. Here the closing round of the end of the petal affords a new point of resistance to the downward passage of plates, and, as a result, a secondary type of "plate-crushing" is developed.

In the Nucleolitidae and "Cassidulidae," although most of the ambulacrum is built up of primaries, there is, near the peristome, a phyllode or "hypophyllode," composed of demi- or occluded plates. There is no definite difference in the coarseness or arrangement of the tubercles in this region, and the structure is, as I have previously shown (Geol. Mag. 1911), cognate with that of the Holoctypoida or Centrechinoida.

In all the groups mentioned above, little or no interruption of the growth of new coronal plates from the oculars occurs during the life of the individual. Among the Spatangidæ, the most

Text-fig. 41.



Adoral part of ambulacrum of *Pygaster semisulcatus*, showing the slight influence of tuberculation on the position of sutures.

highly specialised of modern Echinoids, the full complement of plates is early attained, and, for the most part, subsequent growth

is the result of enlargement of the plates already developed, rather than of the addition of new ones. In many genera a considerable development of large tubercles occurs (though rarely on the ambulacra), and no distortion of the sutures follows such a secondary development. But in *Echinocardium cordatum* (and probably in *Heteraster oblongus*), ambulacrum III. continues to develop in the more primitive Echinoid way throughout life. And here, with an exceptional character in the manner of growth, we find a corresponding exception in the structure. Practically no tubercles, and no granules of considerable size, occur on the area, but the "plate-crushing" is carried to a degree of complexity surpassing that of any other Echinoid.

It is important to remember that in the Regularia, Holothyridida, and Nucleolitidae, the "plate-crushing," when it exists, is always most strongly developed towards the peristome. Moreover, in most members of these groups the arrangement of the compound plates is founded on a regularly three-fold plan. In the Clypeastroida and Spatangidae, when "plate-crushing" occurs, it is restricted to some part of the adapical surface, and there seems to be no definite pattern in its arrangement.

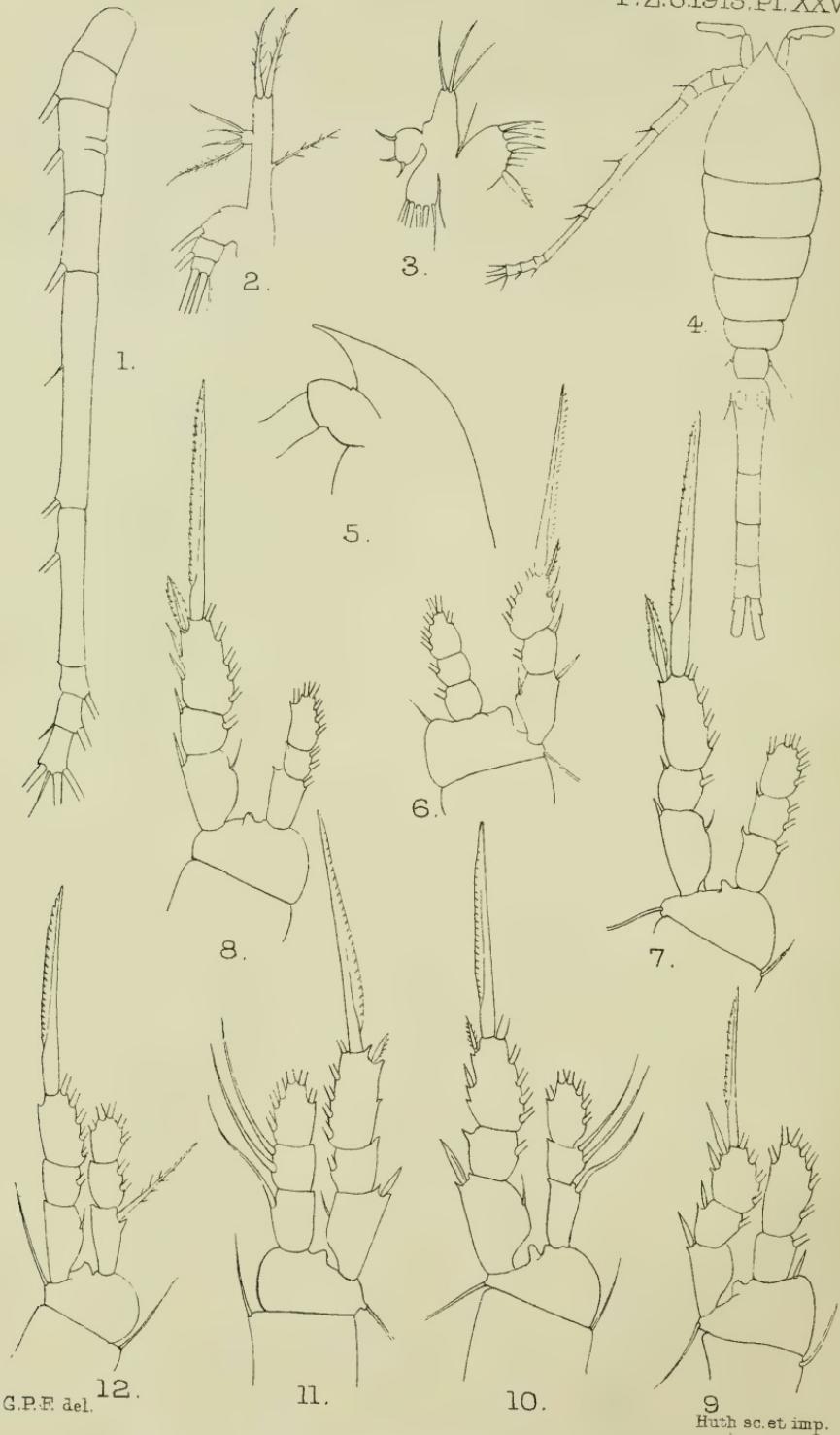
It seems safe to conclude that the structures found in the last-named sections have no phylogenetic connection with those of the former groups, and a reason for their development must be sought. From the discussion given above it seems clear that the only feasible explanation lies in the assumption that the high specialisation of the petaloid parts of Clypeastroid and Spatangid ambulacra precludes the passage of plates from those regions to lower positions. The "plate-crushing" is confined to the petals, and the remainder of the areas have, in large measure, lost their distinctively ambulacral characters as regards the plating.

For the Irregular Echinoids, mechanical compression due to the growth of new plates seems the only available cause of the development of compound plates. To my mind it affords the most reasonable explanation of similar structures among the Regularia. The development of a tubercle is a superficial phenomenon, having no visible influence on the texture of the plate-substance in the deeper layers. It seems likely that the lateral expansion of a tubercle may cause local distortion of sutures at the outer surface (although in many cases it obviously has no such influence), but, at the most, this effect would be local and secondary.

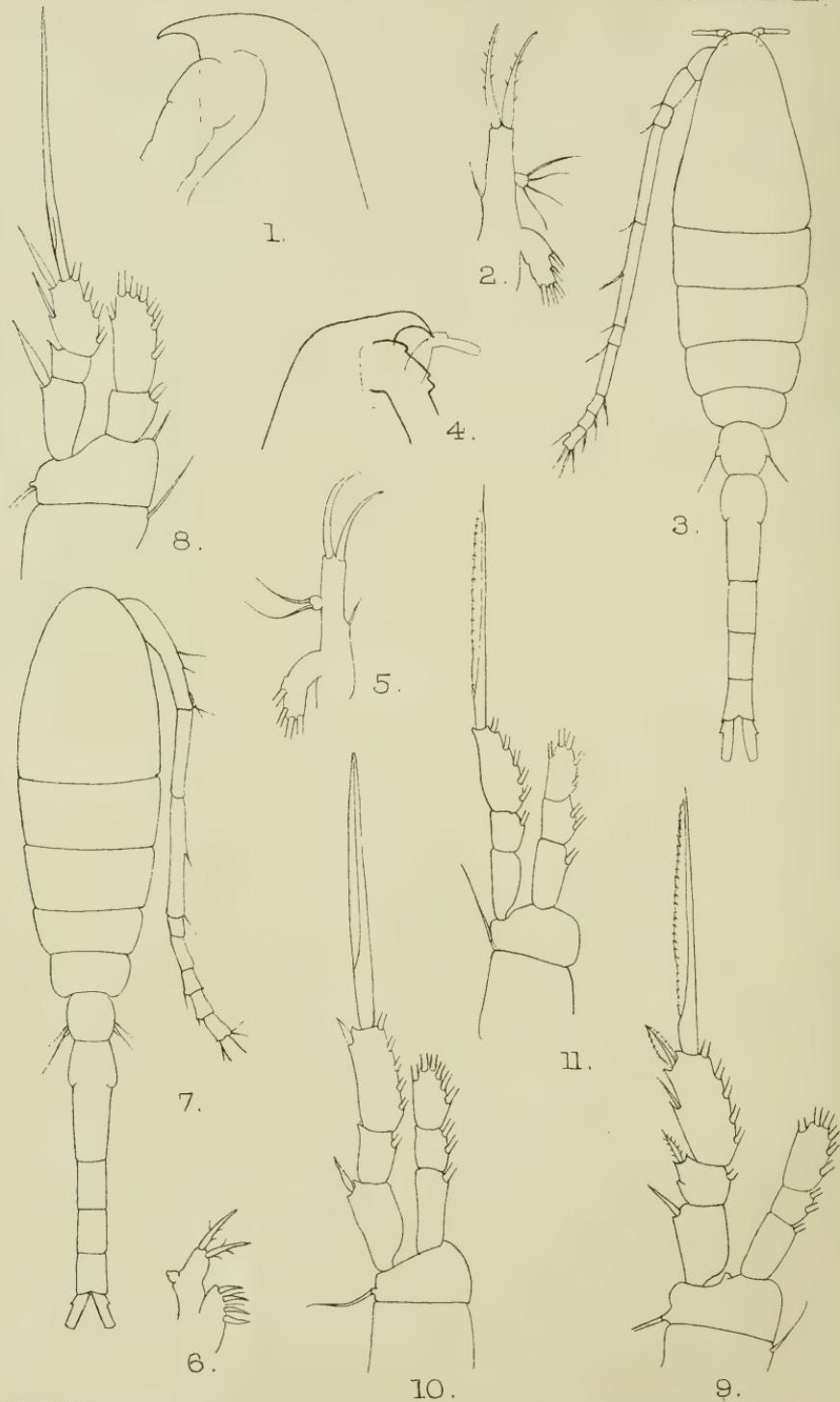
VII. Summary.

A new method for exposing sutures in dried specimens of Echinoids is described. The method combines the processes of staining and etching; depends on the presence of organic tissue between the plates; and gives a fairly lasting result easily photographed.

The complex structure of the anterior ambulacrum of *Echinocardium cordatum* is described in detail for the first time, and a



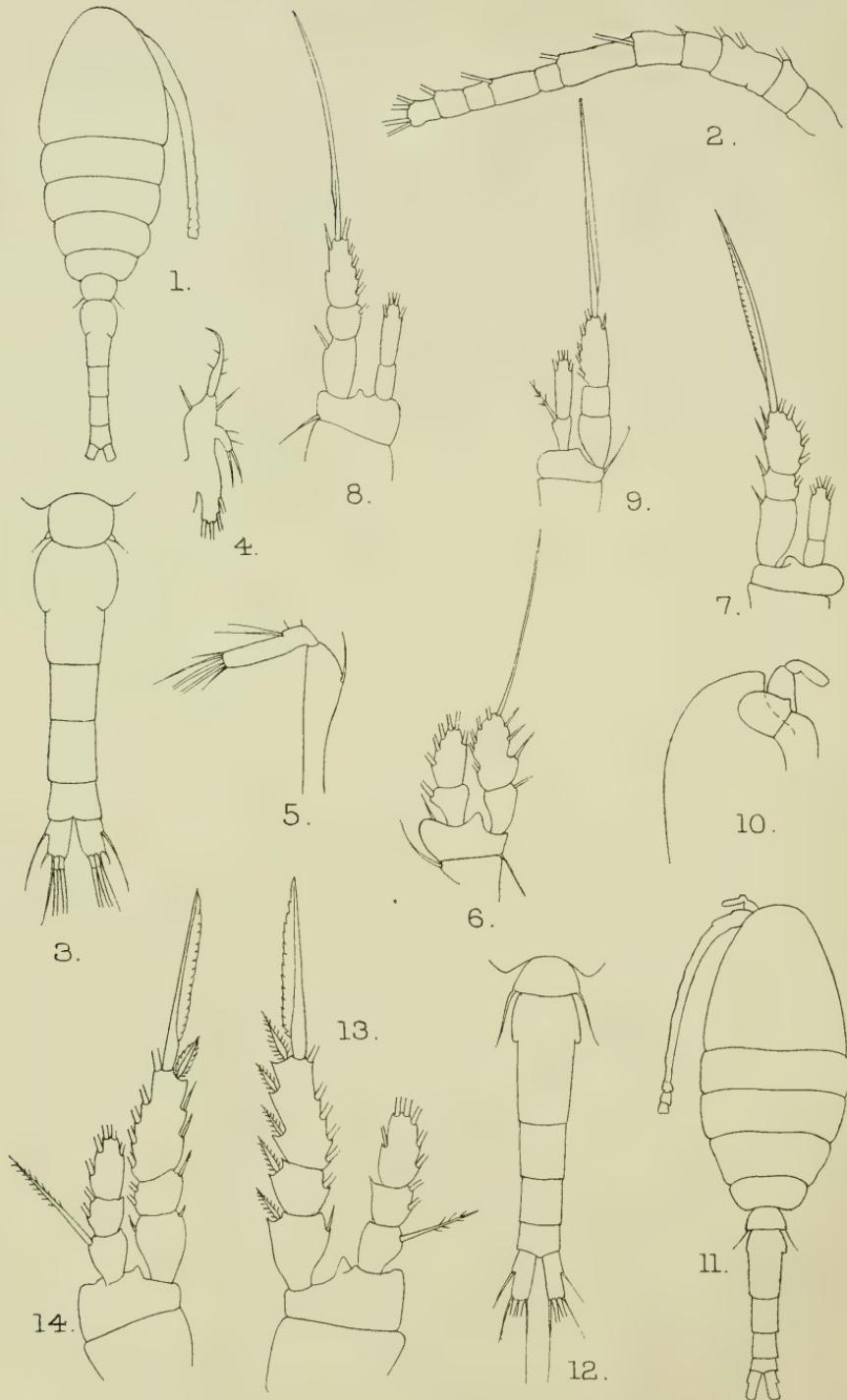
1-8. OITHONA VIVIDA. 9-12. O. FALLAX.

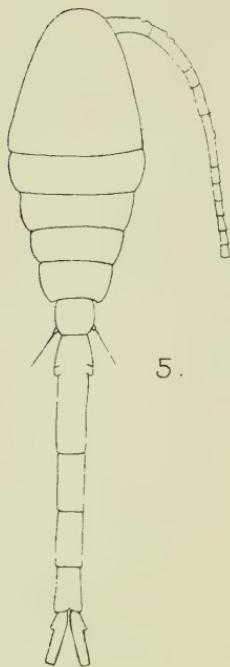


G.P.E. del.

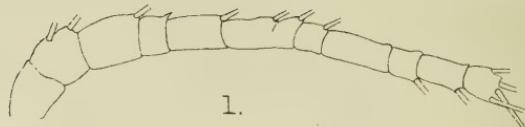
Huth sc. et imp.

1-3. OITHONA FALLAX. 4-11. O. DECIPiens.





5.



1.



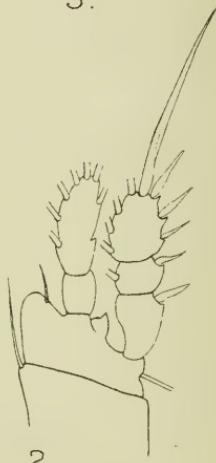
3.



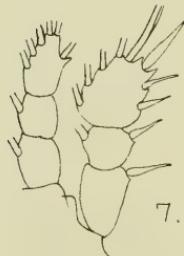
6.



4.



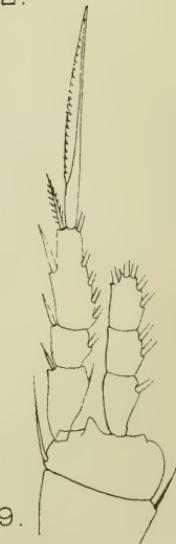
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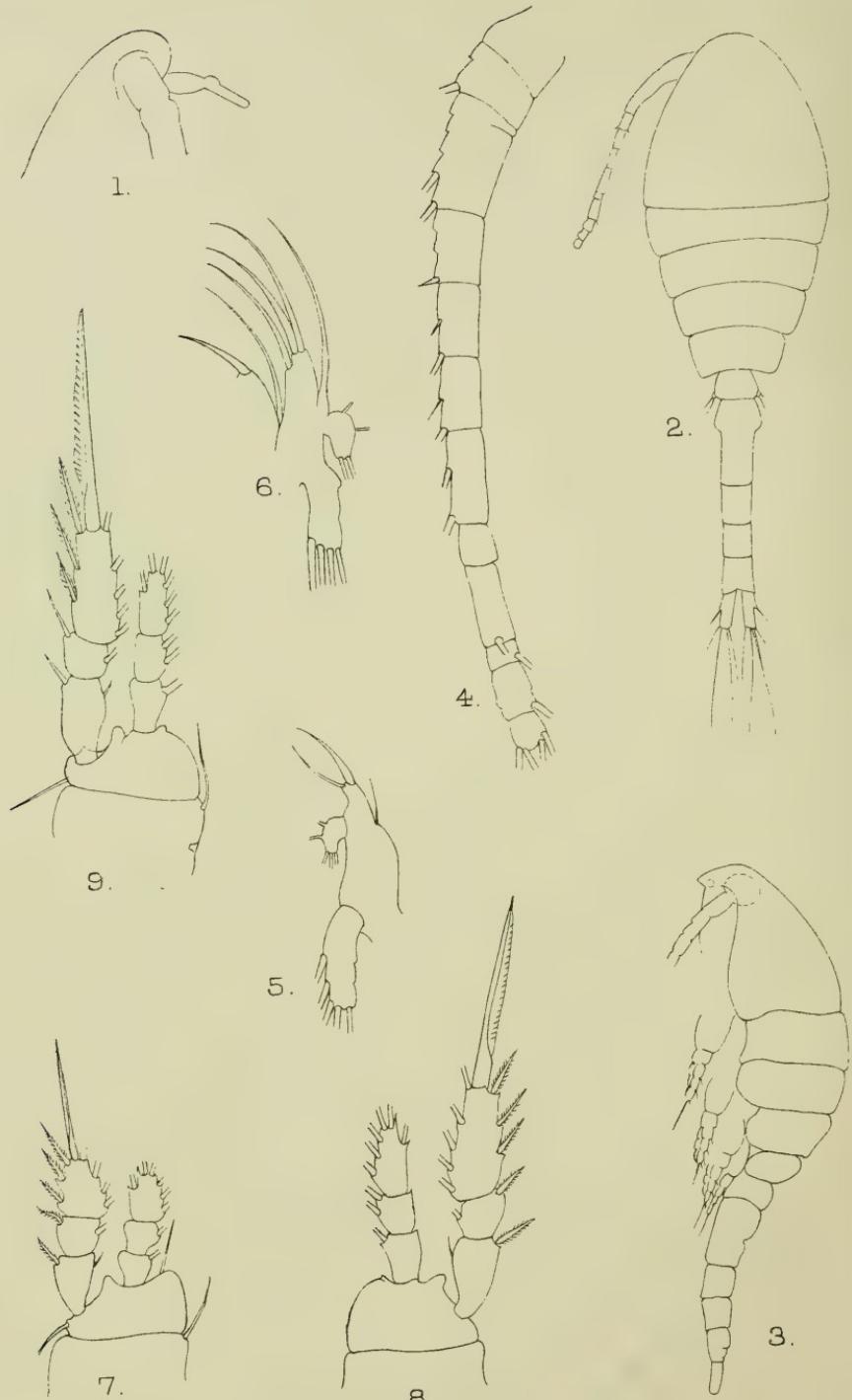
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8.



9.



G.P.F del.

Huth sc. et imp.

1. PAROITHONA PULLA. 2-9. OITHONA OCULATA.

corresponding development in *Heteraster oblongus* and *Schizaster* is indicated.

A general description of the growth of compound ambulacrals among the great groups of Echinoids is given; and, as a result of the facts brought forward, it is argued that "plate-crushing" is due solely to the mechanical "growth-pressure" caused by the development of new plates; while the appearance of tuberculation corresponding in arrangement with the ambulacral elements is considered to be an after-effect of their fundamental characters, and to modify very slightly, if at all, the structure of the areas.

EXPLANATION OF PLATE XXVI.

- Fig. 1.** Denuded test of *Echinocardium cordatum*, showing the relative smoothness and the crowding of the pores, of ambulacrum III.
Fig. 2. The same specimen, after staining and etching, showing the plate sutures particularly in ambulacrum III.

14. Plankton from Christmas Island, Indian Ocean.—II.
On Copepoda of the Genera *Oithona* and *Paroithona*.
By G. P. FARRAN.*

[Received November 5, 1912; Read February 4, 1913.]

(Plates XXVII.-XXXI.†)

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In a previous paper published in the Proceedings of this Society (1911, pp. 282-296), an account was given of the species of *Coryceus* and *Corycella* found in a small collection of Plankton made in 1908 by Sir John Murray, K.C.B., F.R.S., and Dr. C. W. Andrews, F.R.S., at Christmas Island, in the Indian Ocean, and presented to the British Museum by Sir J. Murray. The following account deals with the species of *Oithona* and *Paroithona* found in the same collection.

* Communicated by Dr. W. T. CALMAN, F.Z.S.

[†] For explanation of the Plates see p. 193.

Of the genus *Oithona* eleven species were represented. Five of these,

<i>O. plumifera</i> ,	<i>O. robusta</i> ,
<i>O. setigera</i> ,	<i>O. nana</i> ,
<i>O. linearis</i> ,	

are already known. The remaining six appear to be unknown and are described below under the following names:—

<i>O. vivida</i> ,	<i>O. attenuata</i> ,
<i>O. decipiens</i> ,	<i>O. simplex</i> ,
<i>O. fallax</i> ,	<i>O. oculata</i> .

The closely allied genus *Paroithona*, previously known from a single species in the N.E. Atlantic, is represented by a new species, *P. pulla*.

The fact that twelve species, out of the twenty contained in the two genera, were present will serve to illustrate the remarkable richness of the collection.

The number of gatherings in the collection was eight. Three of these were taken with nets of larger mesh than the rest, and contained only those species which exceeded 1 mm. in length. The smaller species, including all the new forms, were found exclusively in the other five.

Notes on the Species.

OITHONA SETIGERA Dana.

Found in five gatherings and was, next to *O. plumifera*, the commonest species of *Oithona*.

This species was described by Dana (8) in 1849, from specimens taken in the Pacific, and Giesbrecht (13) gave a complete diagnosis of it also from Pacific specimens. Most of the Christmas Island specimens could be recognised by their large size (1·6 to 1·7 mm., with a few as large as 1·9 mm.), and by the possession of well-marked clavate setæ, usually coloured red, on the outer edges of the second basal joints of the swimming-feet. In a few specimens, however, these setæ were long and slender and did not show signs of thickening. These specimens agree with *O. pelagica* which I described (11) from the west coast of Ireland, and also with *O. tropica* described by Dr. Wolfenden (17) from a single specimen from the Maldives. Other specimens showed a good deal of variation in the amount of the thickening, and in some instances the setæ on the fifth pair of feet were thickened and coloured.

As regards *O. tropica*, Wolfenden states that "the inner marginal bristles of the 2nd basals are not swollen as in *O. setigera*." In this sentence the word "inner" is evidently a clerical error for outer. The proportional lengths of the joints of the 1st antennæ, as given for *O. tropica*, differ from those found in *O. setigera*, but the difference can be explained by supposing the 3rd and 4th and the 6th and 7th joints, the segmentation

between which is imperfect, to be united and the 8th and 10th joints each to have been divided into two.

It seems, then, that *O. pelagica* and *O. tropica* cannot be maintained as species distinct from *O. setigera*, but the fact is worth noting that, in the N.E. Atlantic, *O. setigera*, whether the cause be racial or environmental, is not found with thickened setæ, while in tropical regions these setæ are almost always present.

In addition to the large form mentioned above there occurred a very few specimens of a form measuring from 1.20 to 1.26 mm. in length. These are the same size as, and, at first sight, look very like *O. plumifera*, but examination of the appendages shows that they agree with *O. setigera*. The setæ of the basal joints of the swimming-feet are not thickened. There did not appear to be any specimens of intermediate size connecting the larger and smaller forms.

Distribution. North Atlantic, Gulf of Guinea, Mediterranean, Gulf of Suez, Indian Ocean, Pacific Ocean.

OITHONA PLUMIFERA Baird.

Present in all the gatherings and very common in most of them.

Almost all the specimens bore tufted plumose outer-edge setæ on the 2nd basal joints of the first three pair of swimming-feet, and in the few cases where they were absent it seemed probable that the plumose tip of the seta had been broken off. The amount of feathering varied in different specimens. In most cases it was opaque and of a bright red colour; in others it was transparent and colourless and difficult to observe. In the 1st maxilla there was no seta on the 2nd inner lobe and the seta on the endopodite was very minute. The endopodite of the mandible bore only three setæ. The size of the specimens varied from 1.20 to 1.37 mm.

Distribution. Mediterranean, Gulf of Guinea, Red Sea, Arabian Sea, Indian Ocean, Pacific Ocean, Gulf of California, off Cape of Good Hope.

OITHONA LINEARIS Giesbrecht.

This easily recognised species was present in six gatherings, being almost as common as *O. setigera*.

Distribution. Red Sea, Indian Ocean, Pacific Ocean.

OITHONA VIVIDA, sp. n. (Pl. XXVII, figs. 1-8.)

Female (fig. 4).—Length .68-.74 mm.; cephalothorax .37 mm.; abdomen .34 mm.; proportional lengths of abdominal segments and furca 15:40:22:18:17:15.

Rostrum (fig. 5) sharp-pointed and produced anteriorly, as in *O. plumifera* and *O. setigera*.

1st antenna (fig. 1) very slender, reaching to the genital openings; proportional lengths of antennal joints:

1	2	3	4	5	6	7	8	9
11	9	8+3+10	17	53	11+23	5	9	10

There are two imperfect jointings close together in the centre of the third joint and another in the sixth; a row of minute spinules runs along the lower edge of the fourth and fifth joints.

2nd antenna large, robust, of the usual form.

Mandible (fig. 2) with very slender 2nd basal; endopodite with four small setæ, the two central ones being the shortest; exopodite with four large feathered setæ and one slender one.

1st maxilla (fig. 3).—1st inner lobe well developed with the usual setæ; 2nd inner lobe with one fine seta; 3rd inner lobe with three spines; endopodite comparatively large with three very small setæ; exopodite with four setæ.

2nd maxilla and maxillipede of the usual structure but comparatively short.

1st foot (fig. 6): exopodite with 1.1.3 outer edge spines and 1.1.4 inner edge setæ, the seta on the inner edge of the 1st joint being very minute, terminal spine long and slender, longer than the exopodite; endopodite with 0.1.4 inner edge and 0.0.1 outer edge setæ.

2nd foot (fig. 7): exopodite with 1.1.3 outer edge spines and 1.1.4 inner edge setæ, seta on inner edge of 1st joint very minute, terminal spine longer than the exopodite and broader than in the 1st foot; endopodite with 1.2.4 inner edge and 0.0.1 outer edge setæ.

3rd foot (fig. 8): exopodite with 1.1.2 outer edge spines, the most distal very large, the rest very minute, and 1.1.4 inner edge setæ, terminal spine much longer than the exopodite; endopodite with 1.2.4 inner edge and 0.0.1 outer edge setæ.

4th foot rather small: exopodite appears to have 1.1.3 or 1.0.3 very minute slender outer edge spines and 1.1.4 inner edge setæ; endopodite with 1.2.3 outer edge and 0.0.1 inner edge setæ.

5th foot of usual form.

The possession of a pointed rostrum and of a large number of outer edge spines, though reduced in size, on the swimming-feet, and also the presence of a large endopodite on the 1st maxilla, places this species near to *O. robusta*, but the 1st antenna is of a different type and seems to be peculiar in not having a spine on the distal end of the 3rd (primitively 12th) joint. As *O. robusta* is the least specialised of the rostrate Oithonas, so *O. vivida* seems to have taken the first step towards the reduction of the spines on the swimming-feet which is found in the other rostrate species.

Four specimens were found in one gathering.

OITHONA ROBUSTA Giesbrecht.

Found in four gatherings, a few specimens in each.

Distribution. Indian Ocean and Tropical Pacific.

OITHONA DECIPIENS, sp. n. (Pl. XXVIII. figs. 4-11.)

Female (fig. 7).—Length .56-.62 mm.; cephalothorax .34 mm.;

abdomen (including Th. 5) .28 mm., proportional lengths of abdominal segments and furca 12:26:12:10:9:8. Rostrum (fig. 4) pointed, not visible in dorsal view, similar to that of *O. similis* but more hooked at the tip. Form of body slender.

1st antenna just reaches to the genital openings; proportional lengths of joints:

1	2	3	4	5	6	7	8	9
(16+16)	(3+10+13+12)	(14+14)	(14+15+15+16)	12	28	10	12	14

the first four joints being subdivided by imperfect jointing in the proportions indicated; there is a small spine on the end of the 2nd joint.

2nd antenna very small.

Mandible (fig. 5): endopodite small with two setæ, exopodite with five setæ.

1st maxilla (fig. 6) small, endopodite without setæ.

2nd maxilla and maxillipede comparatively short and weak but of usual form.

1st foot (fig. 8): exopodite three-jointed with 1.0.2 outer edge spines and 0.0.4 inner edge setæ; endopodite two-jointed with 1.5 inner edge setæ and 1 outer edge seta.

2nd foot (fig. 9): exopodite with 1.1.2 outer edge spines and 0.1.5 inner edge setæ; endopodite with 1.2.4 inner edge and 0.0.1 outer edge setæ; an inner edge seta was found on the 1st basal of the 1st and 2nd feet, but not of the 3rd and 4th, an outer edge seta was present on the 2nd basals of all the swimming feet.

3rd foot (fig. 10): exopodite with 1.0.1 outer edge spines and 0.1.5 inner edge setæ; endopodite with 1.2.4 inner edge and 0.0.1 outer edge setæ.

4th foot (fig. 11): exopodite without outer edge spines and with 0.1.5 inner edge setæ; endopodite with 1.2.3 inner edge and 0.0.1 outer edge setæ.

5th foot of usual form.

This species resembles *O. similis* so closely that it is almost impossible to distinguish it without examination of the spines on the swimming-feet. It differs from that species in the absence of a spine on the 2nd joint of the exopodite of the 1st foot and in the presence of a spine on the corresponding joint of the 2nd foot. It also differs in not having an outer edge spine on the 3rd joint of the exopodite of the 4th foot, unless that spine may have been accidentally knocked off in all the specimens examined, as sometimes happens in the case of *O. similis*, and in having a well-developed spine on the centre of the outer margin of the 3rd joint of the exopodite of the 2nd foot, which in *O. similis* is only represented by a small tooth.

About thirty-five specimens were found in one gathering.

OITHONA FALLAX, sp. n. (Pl. XXVII. figs. 9-12; Pl. XXVIII. figs. 1-3.)

Female (Pl. XXVIII. fig. 3).—Length .88-.94 mm.; cephalo-
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thorax .48 mm.; abdomen (including Th. 5) .42 mm.; proportional lengths of abdominal segments and furca 9 : 20 : 9 : 9 : 8 : 6.

Rostrum (Pl. XXVIII. fig. 1) pointed, not visible in dorsal view, similar to that of *O. similis* and *O. decipiens*.

1st antenna reaches to the beginning of the genital segment; proportional lengths of joints :

1	2	3	4	5	6	7	8	9
(24 + 28)	(4 + 12)	(16 + 16)	40	(20 + 20 + 20 + 22)	(16 + 38)	14	16	20

the first three and the 5th and 6th joints being subdivided by imperfect jointing in the proportions indicated.

2nd antenna slightly larger comparatively than in *O. decipiens*.

Mandible (Pl. XXVIII. fig. 2): endopodite with four setæ.

1st maxilla: exopodite with three moderately strong terminal setæ, endopodite with one small seta.

2nd maxilla and maxillipede of the usual type.

1st foot (Pl. XXVII. fig. 9): exopodite with 1.1.2 outer edge spines and 0.1.4 inner edge setæ, terminal spine shorter than the exopodite; endopodite two-jointed with 1.5 inner edge and 1 outer edge setæ.

2nd foot (Pl. XXVII. fig. 10): exopodite with 1.0.2 outer edge spines and 1.1.5 inner edge setæ; the inner edge seta on the 1st joint is small; terminal spine approximately equal to the exopodite; there is a small tooth on the outer edge of the 3rd joint of the exopodite proximal to the first spine; endopodite with 1.2.4 inner edge and 1 outer edge setæ.

3rd foot (Pl. XXVII. fig. 11): exopodite with 1.0.1 outer edge spines and 1.1.5 inner edge setæ, inner edge seta on 1st joint small; there is a small tooth in the middle of the outer edge of the 3rd joint; terminal spine slightly longer than the exopodite.

4th foot (Pl. XXVII. fig. 12): exopodite with 0.0.0 outer edge spines and 1.1.5 inner edge setæ, inner edge seta on 1st joint small; terminal spine slightly longer than the exopodite; endopodite with 1.2.3 inner edge and 1 outer edge setæ.

There is a well-developed outer edge seta on the 2nd basals of all the swimming-feet and an inner edge seta on the 1st basals.

5th feet of usual form.

This species, like *O. decipiens*, can with difficulty be distinguished from *O. similis* without examination of the swimming-feet. The shorter terminal spines and the presence of two outer edge spines on the 3rd joint of the exopodite of the 2nd foot and of a small inner edge seta on the 1st joints of the 2nd to 4th feet are the distinguishing characters which can be most easily observed.

Four specimens were found in three gatherings.

OITHONA NANA Giesbrecht.

Occurred in five gatherings, but in two only was it numerous.

Distribution. N. Atlantic, Mediterranean, Red Sea, Arabian Sea, Indian Ocean, Gulf of California, Cape of Good Hope.

OITHONA ATTENUATA, sp. n. (Pl. XXX. figs. 3-7.)

Female (fig. 5).—Length .88 mm.; cephalothorax .4 mm.; abdomen (including Th. 5) .48 mm., proportional lengths of abdominal segments and furca 16:8:8:6.5:8; furcal rami long and narrow, arrangement of setæ as in *O. nana*. Front of cephalon (fig. 3) slightly produced but not pointed.

1st antenna (fig. 4) reaches to the beginning of the genital segment; proportional lengths of joints :

1	2	3	4	5	6	7	8	9	10	11
16	28	9	19	31	10	10	8	8	11	9

Small spine on the end of the 3rd joint.

2nd antenna comparatively large, of the usual structure.

Mandible : 2nd basal with one stout terminal seta; endopodite large, rounded, with four setæ; exopodite with five setæ.

1st maxilla : structure not made out.

2nd maxilla and maxillipede as in *O. nana*.

Swimming-feet (figs. 6, 7) with three-jointed exopodites and endopodites; exopodites of 1st to 3rd feet with 1.1.3 outer edge spines; exopodite of 4th foot with 1.1.2 outer edge spines; terminal spines of 2nd and 3rd feet shorter than the exopodites; short strong seta on the inner edge of the 1st joint of the exopodites of the 2nd and 3rd feet, not seen on the 1st foot.

5th feet of the usual form.

This species is closely allied to *O. nana* and differs mainly in the long drawn-out abdomen and furca and in the longer 1st antenna.

A single specimen was found in the collection.

OITHONA SIMPLEX, sp. n. (Pl. XXIX. figs. 10-14; Pl. XXX. figs. 1, 2.)

Female (Pl. XXIX. fig. 11).—Length .38-.42 mm.; cephalothorax .24-.26 mm., abdomen (including Th. 5) .14-.16 mm. (Pl. XXIX. fig. 12), proportional lengths of abdominal segments and furca 7:21:9:7:3:7. Rostrum absent, front of cephalon (Pl. XXIX. fig. 10) rounded as in *O. nana*.

1st antenna (Pl. XXX. fig. 1) reaches to the beginning of the 2nd thoracic segment; proportional lengths of joints :

1	2	3	4	5	6	7	8	9	10	11
6	5	9	4	8	11	4	11	5	8	5

2nd antenna rather short and stout.

Mandible, 1st maxilla, 2nd maxilla, and maxillipede as in *O. nana*.

1st foot (Pl. XXX. fig. 2) : exopodite three-jointed with 1.1.3 outer edge spines and 0.1.4 inner edge setæ, terminal spine longer than the exopodite; endopodite two-jointed with 0.5 inner edge and 0.1 outer edge setæ; process of the 2nd basal between the exopodite and endopodite rather large and acute.

2nd foot: exopodite three-jointed with 1.1.3 outer edge spines and 1.1.5 inner edge setæ, inner edge seta on 1st joint very small, terminal spine shorter than the exopodite; endopodite three-jointed with 1.2.4 inner edge and 0.0.1 outer edge setæ; outer edge seta present on 2nd basal, not seen on 3rd and 4th feet.

3rd foot (Pl. XXIX. fig. 13) similar to 2nd except for absence of outer edge seta on 2nd basal.

4th foot (Pl. XXIX. fig. 14): exopodite with 1.1.3 outer edge spines and 1.2.5 inner edge setæ; the most distal outer edge spine is well developed, the others being small and slender; inner edge seta on first joint very small; terminal spine shorter than the exopodite; endopodite with 1.2.3 inner edge and 0.0.1 outer edge setæ.

5th feet very small but appear to be of the usual form with one terminal and one basal seta.

Occurred in two gatherings, about twenty specimens.

In these gatherings it could be recognised by its small size and the shortness of the anal segment, less than the furca.

OITHONA OCULATA, sp. n. (Pl. XXX. figs. 8, 9; Pl. XXXI. figs. 2-9.)

Female (Pl. XXXI. figs. 2, 3).—Length 9 mm.; cephalothorax 5.4 mm.; abdomen (including Th. 5) 3.6 mm.; proportional lengths of abdominal segments and furca 7:18:10:9:8:8; furcal rami about two and a half times as long as wide, with an outer edge seta situated in the middle of the outer margin. Rostrum absent, cephalon slightly produced into a rostral prominence in front of the antennae. The cephalic ganglia form a large bilobed mass, in front of which are situated, in the rostral prominence, a pair of small clear refractive areas.

1st antenna (Pl. XXXI. fig. 4) reaches to the 2nd thoracic segment; proportional lengths of joints:

1	2	3	4	5	6	7	8	9	10	11	12
11	6	16	11	12	12	16	7	13	4	9	6

3rd joint with an imperfect jointing near its proximal end, 4th joint with a small spine distally on its upper margin.

2nd antenna of the usual form.

Mandible (Pl. XXXI. fig. 5): 2nd. basal with two terminal (inner edge) spines and a small seta on its lower (inner) margin opposite the endopodite; endopodite sloped outwards, with three terminal and two inner edge setæ; exopodite with two terminal and three inner edge setæ.

1st maxilla (Pl. XXXI. fig. 6): 1st inner lobe well developed, of the usual form, 2nd inner lobe with one strong seta, 3rd inner lobe with three terminal and one lateral setæ; endopodite moderately large, bent outwards, with two lateral and two terminal setæ; exopodite large, with four terminal setæ, the outermost being slightly the largest.

2nd maxilla and maxillipede (Pl. XXX. fig. 8) of the usual form but rather short.

1st foot (Pl. XXXI. fig. 7): exopodite with 1.1.3 outer edge spines and 1.1.4 inner edge setæ, the inner edge seta on the 1st joint being very small; terminal spine shorter than the exopodite; endopodite with 1.1.4 inner edge and 0.0.1 outer edge setæ; there is a distinct tooth between the terminal and the outer edge seta; inner edge seta on the 2nd basal longer than the first two joints of the endopodite.

2nd and 3rd feet (Pl. XXXI. figs. 8, 9) with 1.1.3 outer edge spines and 1.1.5 inner edge setæ, the inner edge seta on the 1st joint being very small; terminal spine of 2nd foot a little longer than the exopodite and of 3rd foot about equal to it; in both cases it is considerably longer than the endopodite; inner edge seta on 1st basal of 3rd foot and outer edge seta on 2nd basal, both these setæ being absent from the 2nd foot.

4th foot (Pl. XXX. fig. 9): exopodite with 1.1.2 outer edge spines and 1.1.5 inner edge setæ, the inner edge seta on the 1st joint being very small, terminal spine slightly longer than the exopodite; endopodite with 1.2.3 inner edge and 0.0.1 outer edge setæ; 1st basal with inner edge seta, 2nd basal with outer edge seta.

5th foot small, with two terminal setæ and one at its base.

This species is closely allied to *O. rigida*, differing mainly from it in the greater length of the terminal spines of the swimming-feet. In *O. rigida*, as figured by Giesbrecht (14) and also by Cleve (7), these spines are shorter than the terminal joints of the exopodites. Another difference is the comparatively large size of the inner edge setæ on the 1st joints of the exopodites in *O. rigida*. In *O. oculata* they are very small. In size and appearance and in the proportional lengths of the abdominal segments and antennal joints the two species agree very closely.

Common in one gathering, a single specimen in another.

Genus PAROITHONA.

This genus was described in 1908 (10) from specimens taken in deep water off the west coast of Ireland, only one species having been met with until the Christmas Island collections yielded a second representative. The genus is closely allied to *Oithona*, and is distinguished mainly by having a two-jointed endopodite on all the swimming-feet and by the form of the mandible palp. It is questionable whether the differences which separate it from some species of the genus *Oithona* are any greater than those which separate *O. nana* from such species as *O. plumifera* and *O. setigera*, but the occurrence of a second species, closely resembling that first described, is in favour of the retention of the genus.

PAROITHONA PULLA, sp. n. (Pl. XXIX. figs. 1-9; Pl. XXXI. fig. 1.)

Female (Pl. XXIX. fig. 1).—Length 40-43 mm.; cephalothorax 23 mm.; abdomen (Pl. XXIX. fig. 3) (including Th. 5) 19 mm., proportional lengths of abdominal segments and furca 8 : 20 : 9 : 11 : 6 : 6. Rostrum absent, front of cephalon (Pl. XXXI. fig. 1) rounded as in *O. hebes*. Furca with the two longest setae superposed on the inner half of the terminal margin.

1st antenna (Pl. XXIX. fig. 2) reaches to the end of the 2nd thoracic segment; proportional lengths of joints :

1	2	3	4	5	6	7	8	9	10	11
6	5	9	5	7	12	4	7	4	4	6

The 3rd joint is divided into two by a partial jointing, and there appears to be a small spine on the end of the 4th joint.

2nd antenna (Pl. XXIX. fig. 5) rather small and slender, two-jointed.

Mandible (Pl. XXIX. fig. 4): second basal with a single large terminal spine on the inner lobe and a much smaller spine some distance away on either side of it; endopodite bent outwards, with two terminal and two much smaller lateral setæ; exopodite with four subequal setæ.

1st maxilla: structure not properly made out.

2nd maxilla and maxillipede as in *P. parvula*, of the usual *Oithona* structure but rather small.

1st foot (Pl. XXIX. fig. 6) with two-jointed exopodite and endopodite, the division between the 2nd and 3rd joints of the exopodite being only faintly indicated; exopodite with 1.1.2 outer edge spines and 0.1.4 inner edge setæ, the terminal spine considerably longer than the exopodite; endopodite with 1.4 inner edge and 0.1 outer edge setæ; 1st basal with an inner edge and 2nd basal with an outer edge seta.

2nd to 4th feet with three-jointed exopodites and two-jointed endopodites.

2nd foot (Pl. XXIX. fig. 7): exopodite with 1.1.2 outer edge spines and 0.1.5 inner edge setæ, terminal spine longer than the exopodite; endopodite with two inner edge, one terminal and one outer edge setæ on the distal end of the 2nd joint; no setæ seen on the basal joints.

3rd foot (Pl. XXIX. fig. 8): exopodite with 1.0.1 outer edge spines and 0.1.5 inner edge setæ; there is a small tooth on the middle of the outer edge of the 3rd joint; terminal spine very slender, longer than the exopodite; endopodite as in 2nd foot; 2nd basal with an outer edge seta, no seta on 1st basal.

4th foot (Pl. XXIX. fig. 9): exopodite with 0.0.1 outer edge spines and 0.0.5 inner edge setæ, terminal spine longer than the exopodite; endopodite as in 2nd and 3rd feet except for a stout feathered seta on the inner edge of the 1st joint; 2nd basal with an outer edge seta, no seta on 1st basal.

5th foot very small with a short terminal and a basal seta.

Four specimens were found in one gathering.

This species seems to agree in appearance with *Oithona hebes*, but differs in the jointing and spinulation of the swimming-feet. In structure it is separated from *Paroithona parvula*, which it closely resembles, by the reduction in number of the setæ on the endopodites of the swimming-feet. Not much reliance can be put on the presence or absence of setæ on the basal joints of the swimming-feet, as they may have been overlooked in the descriptions of both species.

The following is an attempt to draw up a diagnostic table of the species of *Oithona* and *Paroithona* of which a recognisable description exists, which will assist in the identification of the species described above. The number following each name refers to the paper in which it was first described.

1. Rostrum present.

A. Rostrum antero-ventrally directed, visible in dorsal view.

- a. Exop. of 1st foot with 1.1.2 outer edge spines.
 - aa. 2nd basals of swimming-feet with plumose setæ; length 1·0-1·5 mm. *O. plumifera* (1).
 - bb. 2nd basals with smooth setæ; length 1·0-1·16 mm. *O. atlantica* (11).
- b. Exop. of 1st foot with 1.1.3 outer edge spines.
 - aa. Exop. of 4th foot with 0.0.1 outer edge spines; length 1·25-1·35 mm. *O. frigida* (15).
 - bb. Exop. of 4th foot with 1.1.3 outer edge spines; length 1·68-1·74 mm. *O. vivida*.
 - cc. Exop. of 4th foot with 0.0.2 outer edge spines; length 1·2-1·9 mm. *O. setigera* (8).

B. Rostrum ventrally directed, not visible in dorsal view.

- a. Exop. of 1st foot with 1.0.2 outer edge spines; length 1·56-1·62 mm. *O. decipiens*.
- b. Exop. of 1st foot with 1.1.2 outer edge spines.
 - aa. Exop. of 2nd foot with 1.0.1 outer edge spines; length 1·73-1·8 mm. *O. similis* (6).
 - bb. Exop. of 2nd foot with 1.0.2 outer edge spines; length 1·88-1·94 mm. *O. fallax*.
- c. Exop. of 1st foot with 1.1.3 outer edge spines.
 - aa. Exop. of 4th foot with 1.1.2 outer edge spines.
 - a. Rostrum long, slender, straight; length 1·65 mm. *O. robusta* (13).
 - b. Rostrum short, curved; length 7 mm. *O. brevicornis* (13).
 - bb. Exop. of 4th foot with 0.0.1 outer edge spines; length 1·07-1·12 mm. *O. linearis* (12).

2. Rostrum absent.

A. Endop. of 2nd-4th feet three-jointed.

- a. 5th foot with one terminal seta.
 - aa. 4th foot with 1.1.3 outer edge spines; length 1·38-1·42 mm. *O. simplex*.
- bb. 4th foot with 1.1.2 outer edge spines.
 - a. Cephalothorax much longer than abdomen; length 1·55 mm. *O. hebes* (13).
 - b. Cephalothorax slightly longer than abdomen; length 1·50-1·53 mm. *O. nana* (13).
 - γ. Cephalothorax shorter than abdomen; length 1·88 mm. *O. attenuata*.

- b. 5th foot with two terminal setæ.
- aa. Mandible with large spines on 2nd basal; length '64 mm. *O. minuta* (16).
- bb. Mandible with small spines on 2nd basal.
- a. Terminal spines of exopodites of swimming-feet very long; length '9 mm. *O. oculata*.
- β. Terminal spines of exopodites of swimming-feet shorter than the 3rd joint; length '75-'85 mm. *O. rigida* (14).
- B. Endop. of all swimming-feet two-jointed (Genus *Paroithona*).
- a. Exop. of 4th foot with 1.1.1 outer edge spines; length '46 mm. *P. parvula* (10).
- b. Exop. of 4th foot with 0.0.1 outer edge spines; length '40-'43 mm. *P. pulla*.

I have omitted from the table *O. challengerii* (3) (4), *O. spinifrons* (2), *O. spinirostris* (5), *O. helgolandica* (5), and *O. pygmaea* (2). The identity and probable synonymy of these species have been fully discussed by various writers and it is unnecessary to consider them further.

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EXPLANATION OF THE PLATES,

All the figures have been drawn with the aid of a camera lucida.

PLATE XXVII.

Fig. 1. *Oithona vivida* ♀, 1st antenna.

- | | | | |
|-----|-----------------------|--------------|-------------------------|
| 2. | " | " | mandible palp. |
| 3. | " | " | 1st maxilla. |
| 4. | " | " | dorsal view. |
| 5. | " | " | cephalon, lateral view. |
| 6. | " | " | 1st foot. |
| 7. | " | " | 2nd foot. |
| 8. | " | " | 3rd foot. |
| 9. | <i>Oithona fallax</i> | ♀, 1st foot. | |
| 10. | " | " | 2nd foot. |
| 11. | " | " | 3rd foot. |
| 12. | " | " | 4th foot. |

PLATE XXVIII.

Fig. 1. *Oithona fallax* ♀, cephalon, lateral view.

- | | | | |
|-----|--------------------------|----------------------------|----------------|
| 2. | " | " | mandible palp. |
| 3. | " | " | dorsal view. |
| 4. | <i>Oithona decipiens</i> | ♀, cephalon, lateral view. | |
| 5. | " | " | mandible palp. |
| 6. | " | " | 1st maxilla. |
| 7. | " | " | dorsal view. |
| 8. | " | " | 1st foot. |
| 9. | " | " | 2nd foot. |
| 10. | " | " | 3rd foot. |
| 11. | " | " | 4th foot. |

PLATE XXIX.

Fig. 1. *Paroithona pulla* ♀, dorsal view.

- | | | | |
|-----|------------------------|----------------------------|----------------|
| 2. | " | " | 1st antenna. |
| 3. | " | " | abdomen. |
| 4. | " | " | mandible palp. |
| 5. | " | " | 2nd antenna. |
| 6. | " | " | 1st foot. |
| 7. | " | " | 2nd foot. |
| 8. | " | " | 3rd foot. |
| 9. | " | " | 4th foot. |
| 10. | <i>Oithona simplex</i> | ♀, cephalon, lateral view. | |
| 11. | " | " | dorsal view. |
| 12. | " | " | abdomen. |
| 13. | " | " | 3rd foot. |
| 14. | " | " | 4th foot. |

PLATE XXX.

Fig. 1. *Oithona simplex* ♀, 1st antenna.

- | | | | |
|----|--------------------------|----------------------------|--------------|
| 2. | " | " | 1st foot. |
| 3. | <i>Oithona attenuata</i> | ♀, cephalon, lateral view. | |
| 4. | " | " | 1st antenna. |
| 5. | " | " | dorsal view. |
| 6. | " | " | 3rd foot. |
| 7. | " | " | 1st foot. |
| 8. | <i>Oithona oculata</i> | ♀, maxilliped. | |
| 9. | " | " | 4th foot. |

PLATE XXXI.

Fig. 1. *Paroithona pulla* ♀, cephalon, lateral view.

- | | | | |
|----|------------------------|-----------------|----------------|
| 2. | <i>Oithona oculata</i> | ♀, dorsal view. | |
| 3. | " | " | lateral view. |
| 4. | " | " | 1st antenna. |
| 5. | " | " | mandible palp. |
| 6. | " | " | 1st maxilla. |
| 7. | " | " | 1st foot. |
| 8. | " | " | 2nd foot. |
| 9. | " | " | 3rd foot. |

15. Diagnoses of New Species and Varieties of Agnathous Mollusca from Equatorial Africa. By H. B. PRESTON, F.Z.S.

[Received November 8, 1912: Read February 18, 1913.]

(Plates XXXII.-XXXV.*)

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The species of which descriptions are given in the present paper were chiefly collected in East and East Central Africa by Messrs. Robin Kemp, A. Blayney Percival, and C. W. Woodhouse in their recent travels in those parts of the African continent, and, further, go to show the enormous field for conchological research awaiting the student of this very fruitful region, in many parts of which it would appear that, probably owing to variation in rainfall, altitude, etc., each range of hills has to a certain extent its own special molluscan fauna, often characterised by certain local and peculiar phases not only common to the species but also to the genera occurring in that particular locality.

STREPTAXIS PERCIVALI, sp. n. (Pl. XXXII. fig. 4.)

Shell ovate, somewhat inflated, thin, semitransparent, yellowish white; whorls 5, the earlier whorls regularly increasing, the later proportionately large, the last two distorted, sculptured with fine, very oblique, and closely set costulae which become obsolete on the base of the shell; suture impressed, narrowly margined below; umbilicus moderately narrow, deep; columella outwardly expanded, descending in a strong curve, diffused above into a thin, ill-defined, projecting callus which reaches the upper margin of the labrum; labrum white, narrowly expanded and reflexed; aperture somewhat oblique, roundly ovate.

Alt. 9·25, diam. maj. 7, diam. min. 6 mm.

Aperture: alt. 4, diam. 3·5 mm.

Hab. Northern slopes of Mt. Marsabit, British East Africa (*A. Blayney Percival*).

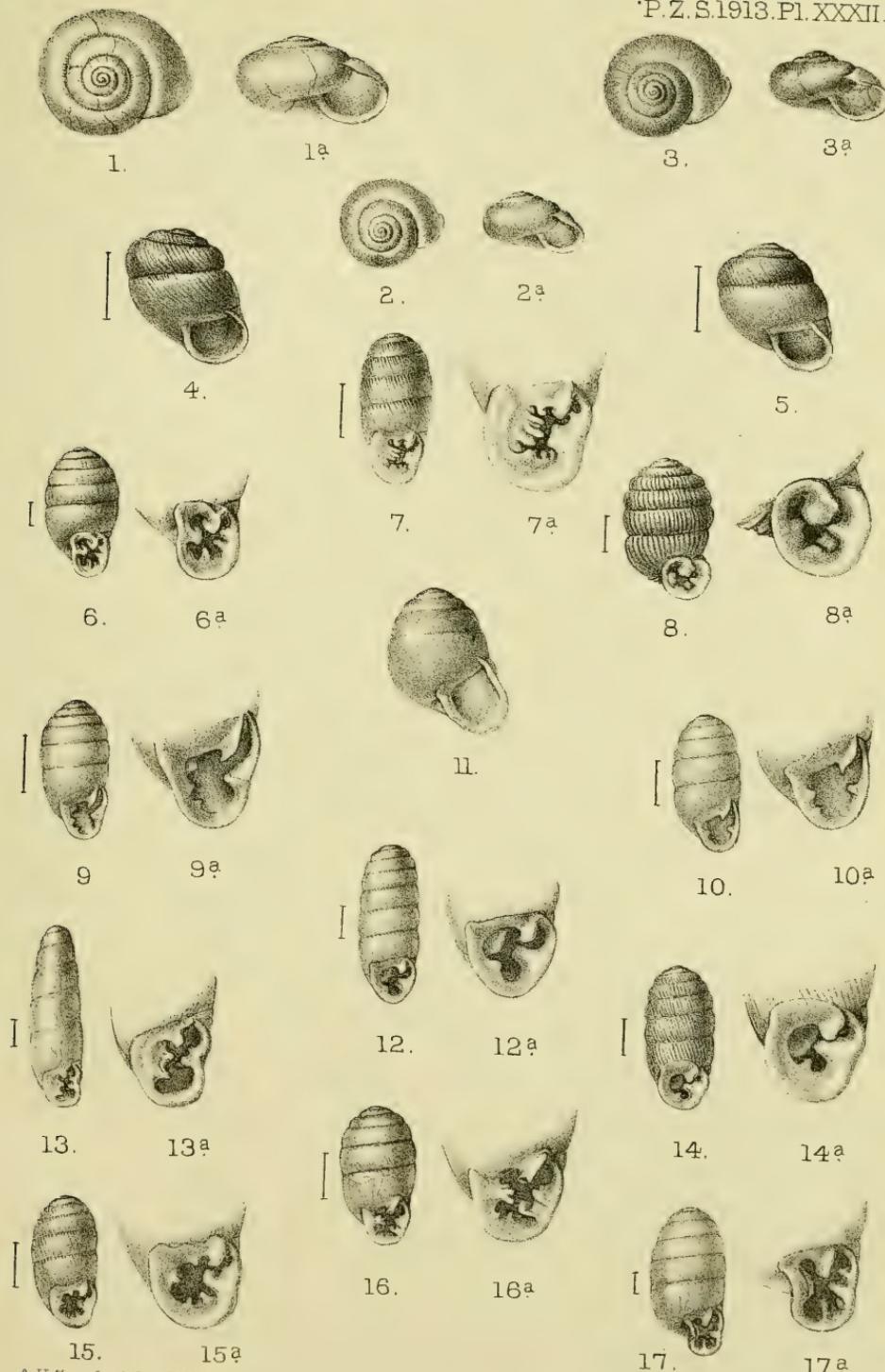
Allied to *S. kirkii* Dohrn †, but differing chiefly in having one whorl less.

STREPTAXIS WOODHouser, sp. n. (Pl. XXXII. fig. 5.)

Shell differing from *S. percivali*, to which it is nearly allied, in its more rectangular and less inflated form, more obtuse apex,

* For explanation of the Plates see p. 217.

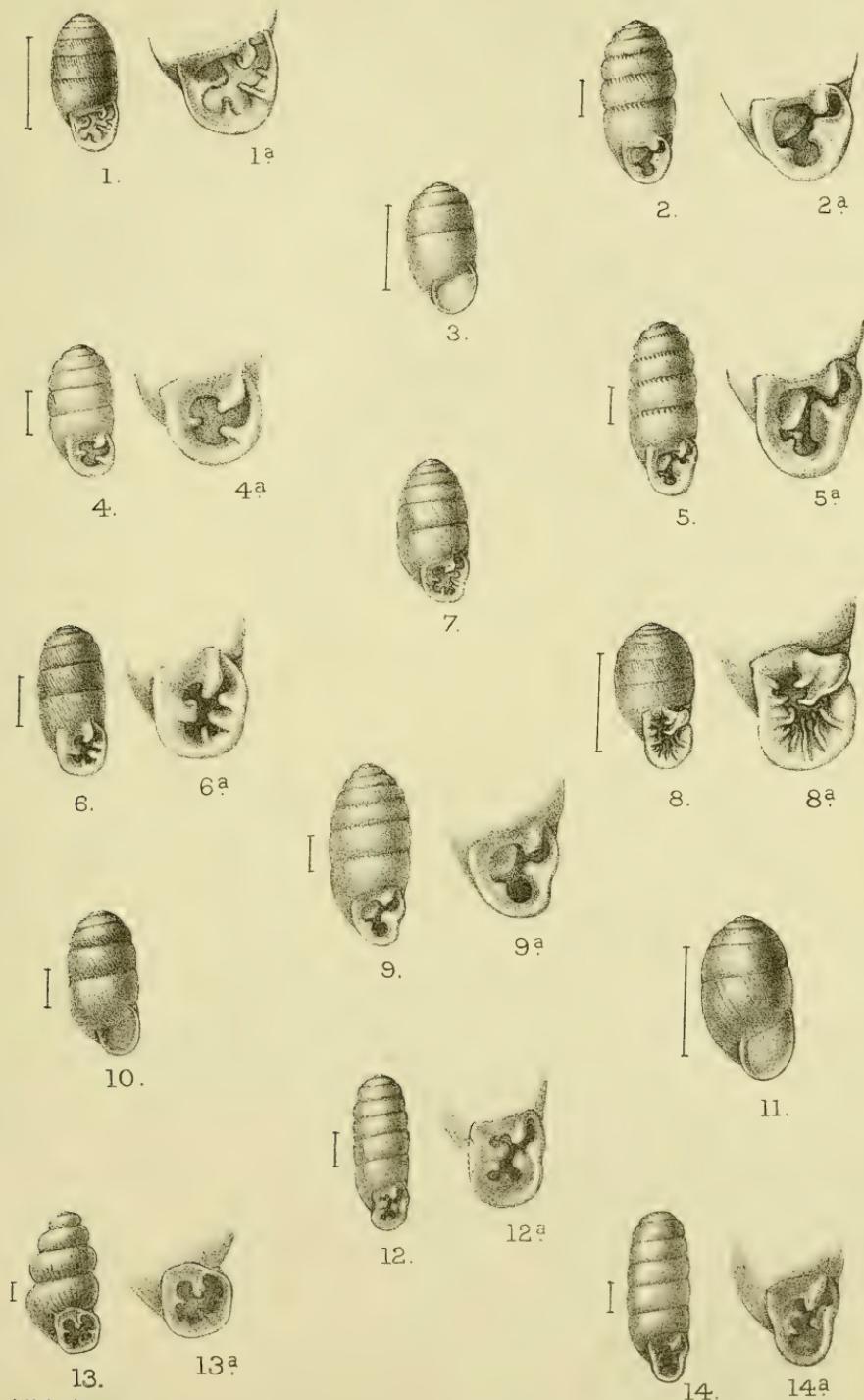
† Proc. Zool. Soc. Lond. 1865, p. 232.



A.H.Searle del. et lith.

Huth imp.

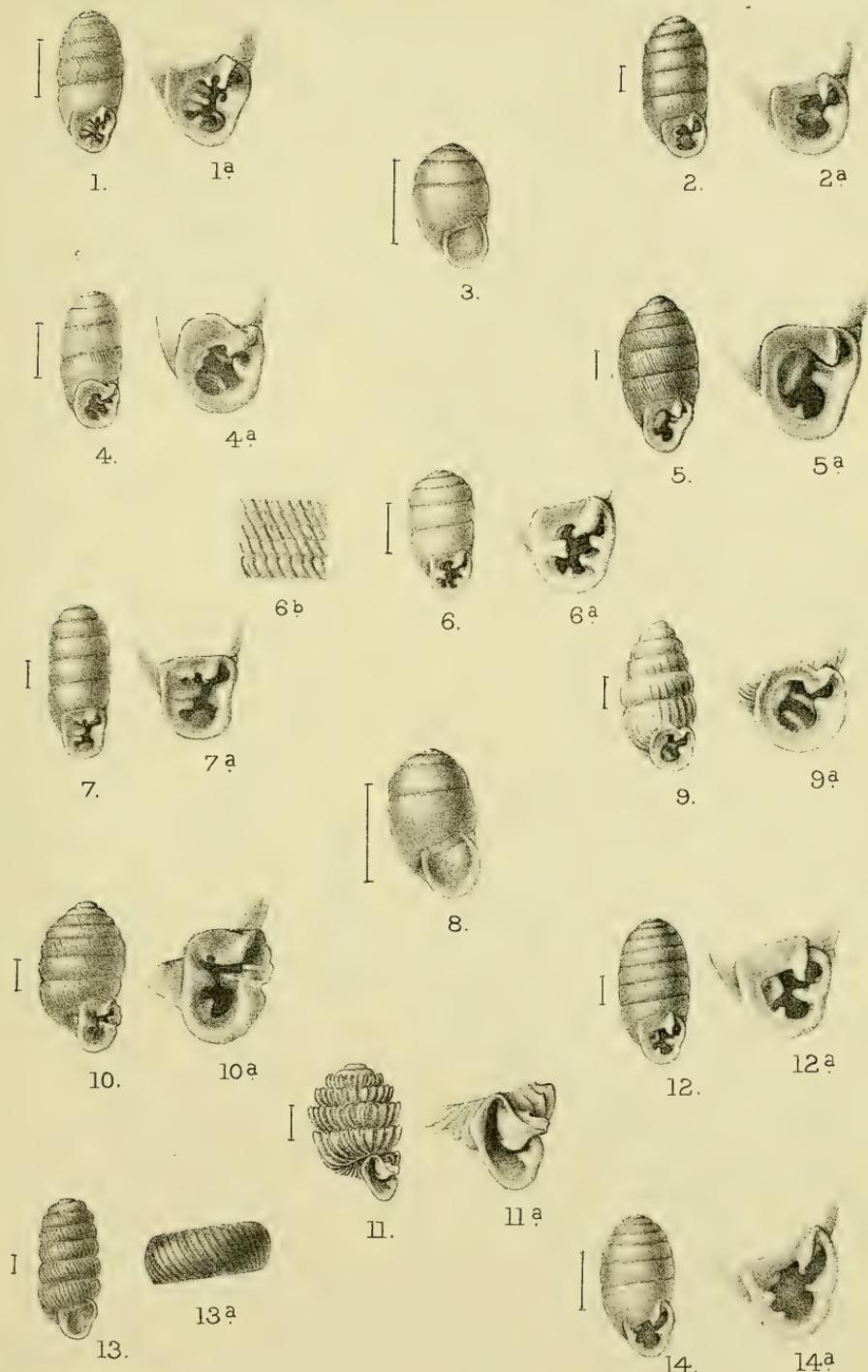
NEW STREPTAXIS AND ENNEA FROM EQUATORIAL AFRICA.



A.H.Searle del et lith.

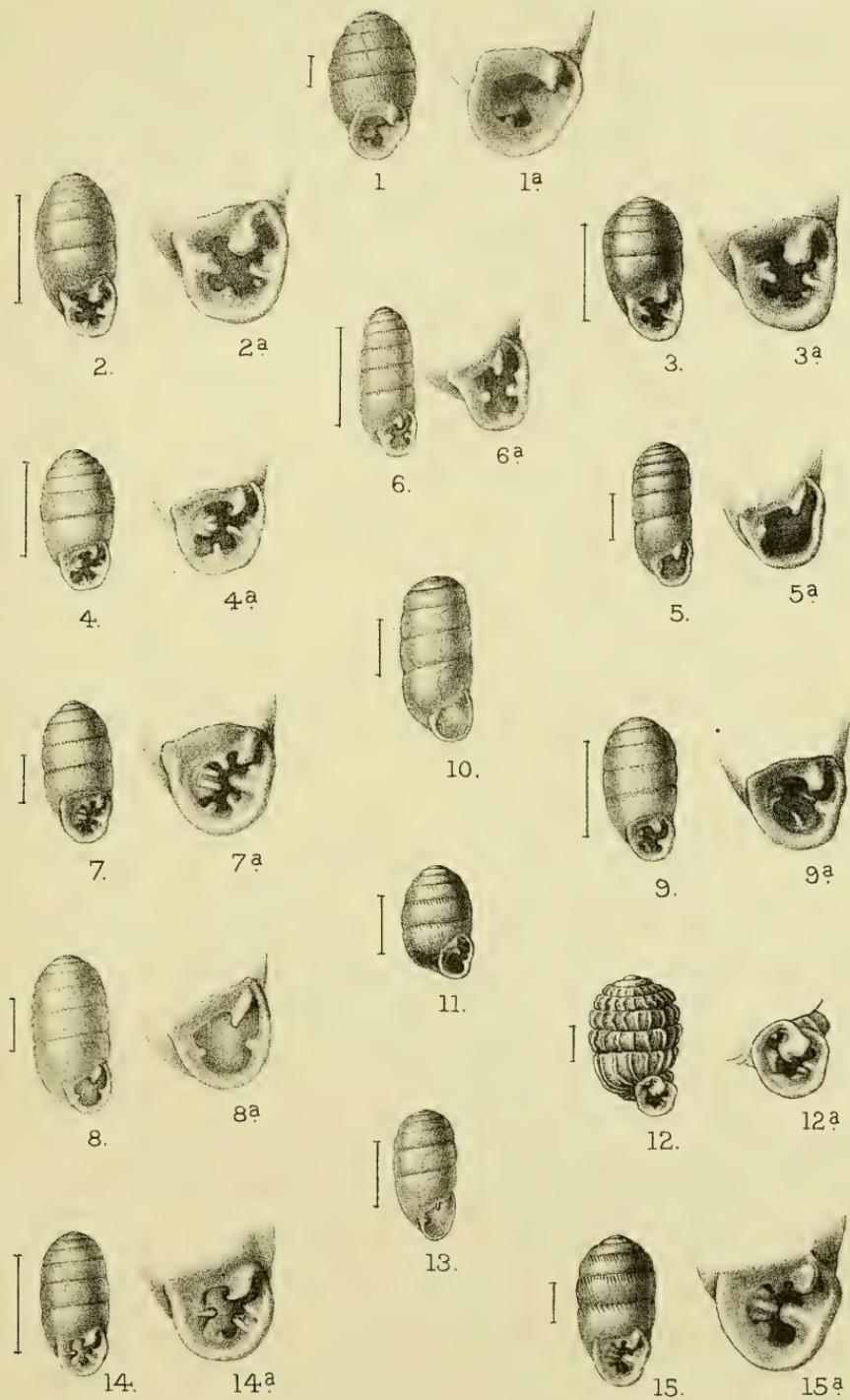
NEW ENNEA FROM EQUATORIAL AFRICA.

Huth, imp.



A.H.Searle, del et lith.

Huth, imp.



and rather coarser transverse sculpture; the umbilicus is narrower and the columella descends almost vertically in a very slight curve and extends above into a thickish, well-defined, parietal callus; the aperture is also much more rectangular than in that species.

Alt. 9·5, diam. maj. 7, diam. min. 5·75 mm.

Aperture: alt. 3·75, diam. 3 mm.

Hab. Mt. Elgon, Uganda (*C. W. Woodhouse*).

STREPTAXIS MARSABITENSIS, sp. n. (Pl. XXXII. figs. 2, 2 a.)

Shell very depressedly turbinate, cream-coloured; whorls $4\frac{1}{2}$, regularly increasing, the earlier whorls smooth, polished, shining, the later whorls sculptured with moderately fine, closely set, arcuate riblets which become obsolete on the base of the shell; suture impressed; umbilicus wide, deep; columella descending in an oblique curve, white, slightly expanded, outwardly extending above into a somewhat thick, well-defined, polished, parietal callus which reaches the upper margin of the labrum; labrum white, considerably expanded and reflexed below, slightly so above, where it is gibbously bent somewhat downwards in front, thus forming, with the parietal wall, a broad, but very shallow, sinus; aperture obliquely and broadly sublunate.

Alt. 7, diam. maj. 13·75, diam. min. 11·25 mm.

Aperture: alt. 5, diam. 4·5 mm.

Hab. Northern slopes of Mt. Marsabit, British East Africa, at an altitude of 4600 feet (*A. Blayney Percival*).

STREPTAXIS URGUESSENSIS, sp. n. (Pl. XXXII. figs. 3, 3 a.)

Shell allied to *S. marsabitensis*, but differing from that species in its larger size, broader, but proportionately no higher, form, and rather coarser transverse sculpture above, though the basal sculpture, while being much more marked, is considerably finer; the umbilicus is proportionately slightly narrower and the columella more obliquely descending; the labrum has converging margins and is more sinuous and gibbously bent downwards over the aperture, which is subrectangular and much broader in shape than is the case with *S. marsabitensis*.

Alt. 9·5, diam. maj. 16, diam. min. 13 mm.

Aperture: alt. 7, diam. 5·5 mm.

Hab. Urguress, British East Africa (*A. Blayney Percival*).

STREPTAXIS DESIDERATA, sp. n. (Pl. XXXII. figs. 1, 1 a.)

Shell suborbicular, very depressedly turbinate, polished, shining, cream-coloured; whorls $5\frac{1}{4}$, regularly increasing, the last somewhat rapidly broadening towards the aperture, marked only with indistinct, transverse growth-ridges; suture impressed, rather coarsely crenellate; umbilicus open, broad, deep; columella descending in an oblique curve above, very oblique below, reflexed, whitish, diffused into a thin, fairly well-defined, and broadly, outwardly extending, parietal callus which reaches the upper

margin of the labrum; labrum thickened, expanded, reflexed and considerably receding below, then scarcely reflexed, projecting and somewhat inwardly bent over the aperture and finally again receding above; aperture very broadly and compressedly, obliquely sublunate.

Alt. 11, diam. maj. 20, diam. min. 16 mm.

Aperture: alt. 8·5, diam. 8·25 mm.

Hab. Urguess, British East Africa (*A. Blayney Percival*).

ENNEA BUCCINA, sp. n. (Pl. XXXII. fig. 11.)

Shell rather large, edentulate, somewhat ovately trigonal, white; whorls $6\frac{1}{2}$, the first five rather rapidly, but regularly increasing, the last very large, rapidly ascending in front, slightly diverging from the axis of the remainder, indistinctly, transversely, arcuately plicate, the plicæ becoming obsolete on the last whorl which is nearly smooth; suture lightly impressed; umbilicus appearing as a very narrow, shallow, curved, elongate depression; columella descending in a slightly oblique curve, diffused above into a thin, opaque, rather ill-defined, parietal callus which terminates just in front of the upper margin of the labrum; labrum white, porcellaneous, outwardly expanded and very narrowly reflexed except near its upper margin where, though thickened, this is scarcely the case, projecting in front, receding below and slightly above to form a shallow curved sinus; aperture very oblique, subrectangular, with rounded base.

Alt. 20·25, diam. maj. 15·5, diam. min. 12·75 mm.

Aperture: alt. (nearly) 9·5, diam. 5·75 mm.

Hab. Burunga, Mount Mikeno, Belgian Congo, at an altitude of 6000 feet (*Robin Kemp*).

ENNEA MARGARITA, sp. n. (Pl. XXXIV. fig. 8.)

Shell ovate, polished, shining, whitish cream-colour; whorls 6, rapidly increasing, the penultimate gibbous, the last slightly oblique, the earlier whorls sculptured with transverse riblets which become obsolete on the later whorls except at the suture, the last whorl marked with very fine, almost imperceptible, scratch-like, spiral striæ; suture impressed, margined below, the margin rather coarsely sculptured by the terminations of the transverse riblets; umbilicus (in the adult) quite closed, the umbilical area being represented by a shallow depression; columella slightly excavated above, obliquely descending below; labrum pure white, expanded and narrowly reflexed, the margins joined by a thin, well-defined, parietal callus; aperture subquadrate, edentulate.

Alt. 12·5, diam. maj. 7·5 mm.

Aperture: alt. 5, diam. 3·25 mm.

Hab. Kigezi, extreme S.W. Uganda, at an altitude of 6000 feet (*Robin Kemp*).

Young specimens are somewhat narrowly, but profoundly, umbilicate.

ENNEA KIVUENSIS, sp. n. (Pl. XXXIV. fig. 3.)

Shell differing from *E. margarita* in its smaller size, rather more cylindrical form, and generally thinner texture; the transverse sculpture is more marked, the penultimate whorl is proportionately less gibbous, and the last whorl is comparatively broader than is the case in that species.

Alt. 10·5, diam. maj. 6·25 mm.

Aperture: alt. 4·25, diam. 3 mm.

Hab. Near Lake Kivu, Belgian Congo (*Robin Kemp*).

ENNEA INNOCENS, sp. n. (Pl. XXXIII. fig. 11.)

Shell scarcely rimate, rather large, cylindrically ovate, cream-coloured, smooth, shining; whorls 6, rather flat, the first three regularly, the remainder rapidly, increasing in size, the last very slightly ascending in front; suture impressed; columella vertically descending, slightly bulging in the middle, narrowly outwardly expanded; labrum white, very narrowly reflexed and dilated below; aperture irregularly subquadrate, edentulate.

Alt. 13·75, diam. maj. 7·5 mm.

Aperture: alt. 5·25, diam. 3·25 mm.

Hab. Jombene Hills, British East Africa, at an altitude of 6000 feet (*Robin Kemp*).

ENNEA ELGONENSIS, sp. n. (Pl. XXXIII. fig. 3.)

Shell allied to *E. innocens*, but much smaller and with more obtuse apex, though having the same number of whorls; the umbilical depression is proportionately broader, the columella descends in a curve, the labrum is not dilated below, and the aperture is ovate instead of being subquadrate as in *E. innocens*.

Alt. 10·75, diam. maj. 5·75 mm.

Aperture: alt. 4, diam. 2·75 mm.

Hab. Mt. Elgon, Uganda (*C. W. Woodhouse*).

ENNEA INGLORIA, sp. n. (Pl. XXXIII. fig. 10.)

Shell small, shortly cylindrical, thin, whitish; whorls 6, the first four regularly increasing, the fifth and sixth rather rapidly increasing in length, but not in breadth, smooth but for coarse growth-markings, the last two whorls convex; suture impressed, strongly crenellate below; perforation very narrow; columella slightly oblique and outwardly expanded; labrum narrowly dilated below and reflexed; aperture edentulate, subovate.

Alt. 4·5, diam. maj. 2·25 mm.

Aperture: alt. 1, diam. 1·5 mm.

Hab. Mt. Nyiro, to the south of Lake Rudolph, at an altitude of 8300 feet (*A. Blayne Percival*).

ENNEA RECTANGULARIS, sp. n. (Pl. XXXV. fig. 10.)

Shell rectangularly cylindrical, with planulate apex, thin, transparent, polished, shining, vitreous, pale greenish; whorls 6, the first two flattened above, the third increasing in length and

breadth, the fourth also increasing in length, but slightly diminishing in breadth, the fifth increasing in length and again in breadth to equal that of the third, the sixth increasing in length but not in breadth; suture impressed, narrowly margined below; columella rather obliquely descending, white, porcellanous; labrum white, narrowly, outwardly expanded and reflexed except near the upper margin, where it becomes almost acute; aperture subquadrate, edentulate.

Alt. 6·75, diam. maj. 3 mm.

Aperture: alt. 1·5, diam. 1 mm.

Hab. Urguess, British East Africa (*A. Blayney Percival*).

ENNEA BACCATA, sp. n. (Pl. XXXII. figs. 10, 10 a.)

Shell cylindrically ovate, cream-coloured; whorls 8, the first very small, the second large in proportion, the third, fourth, fifth, and sixth regularly increasing in length and breadth, the seventh increasing in length, but not in breadth, the eighth increasing in length, but diminishing in breadth, sculptured, especially on the upper whorls, with fine, slightly oblique, closely set, transverse striae; suture lightly impressed; umbilical area presenting a narrow depression; columella not very obliquely descending, spreading above into a very thin, almost imperceptible, but well-defined, parietal callus which reaches to the upper margin of the labrum; labrum sinuous, outwardly expanded, especially at the base, reflexed; aperture armed with an erect, oblique, parietal lamella situated very near the upper margin of the labrum, a rather coarse lamella-like projection on the outer lip, a small nodulous basal denticle at the foot of the columella, above which, and rather more exteriorly situate, occurs another and stronger nodulous denticle, and above this again a rather broad, very interiorly situate, columellar projection.

Alt. 6, diam. maj. 3 mm.

Aperture: alt. 1·25, diam. .75 mm.

Hab. Urguess, British East Africa, at an altitude of 6000 feet (*A. Blayney Percival*).

ENNEA ARTHURI, sp. n. (Pl. XXXII. figs. 9, 9 a.)

Allied to *E. baccata*, but much smaller, with more obtuse apex; it has one whorl less, the first four increasing regularly, the fifth proportionately in length, but not in breadth, while the sixth and seventh increase also in length, but diminish in breadth; the surface is quite smooth, polished and shining, without any trace of the transverse striae which are characteristic of *E. baccata*; the suture is *narrowly margined above*, the labrum is *not* sinuous, the columella is much more oblique and *lacks the internal projection* on the upper part which is so well developed in that species.

Alt. 7·25, diam. maj. 3·75 mm.

Aperture: alt. 3, diam. 1·5 mm.

Hab. Jombene Hills, British East Africa, at an altitude of 4000 feet (*A. Blayney Percival*).

ENNEA ADELPHA, sp. n. (Pl. XXXII. figs. 7, 7 a; Pl. XXXIV. figs. 1, 1 a.)

Shell allied to *E. vicina* Smith* from Chiradzulu, British Central Africa, but differing from that species chiefly in its coarsely crenellate suture and coarse, transverse, plicate sculpture; the small parietal denticle of *E. vicina* is also much more developed and the broad, tridentate projection on the inner margin of the outer lip less so.

Alt. 6·5, diam. maj. 3·25 mm.

Aperture: alt. 2·25, diam. 1·75 mm.

Hab. Between Masaka and Entebbe, extreme S.W. Uganda (*Robin Kemp*).

The very distant locality of *E. vicina*, which is situated to the south of Lake Nyassa, has to a certain extent influenced me in separating the present species.

ENNEA PERTURBATA, sp. n. (Pl. XXXV. figs. 7, 7 a.)

Shell allied to *E. adelpha* and in a measure to *E. vicina* Smith, but shorter and with less convex whorls than either, besides lacking the two internal basal denticles which seem to be a character common to both those species.

Alt. 6, diam. maj. 3 mm.

Aperture: alt. 1·75, diam. 1 mm.

Hab. Mt. Elgon, Uganda (*C. W. Woodhouse*).

ENNEA COENI, sp. n. (Pl. XXXII. figs. 15, 15 a.)

Shell differing from *E. perturbata* and its allies *E. vicina* Smith and *E. adelpha* in lacking the group of three closely situated and projecting lamellæ on the upper part of the columella, which, in the present species, are replaced by a single, small, and slightly curved denticle.

Alt. 5·75, diam. maj. 2·75 mm.

Aperture: alt. 1·5, diam. ·75 mm.

Hab. Mt. Elgon, Uganda (*C. W. Woodhouse*).

ENNEA WOODHOUSEI, sp. n. (Pl. XXXV. figs. 15, 15 a.)

Shell allied to *E. perturbata*, but considerably smaller, with rather coarser and more distant transverse plicæ and more basally constricted aperture; the tridentate projection on the inner side of the outer lip, which is common, not only to the above species, but also to *E. vicina* Smith, and to *E. adelpha*, in the present case appears as a very broad, bidentate, shelf-like protuberance, almost choking the aperture.

Alt. 4·75, diam. 2·5 mm.

Aperture: alt. 1, diam. ·75 mm.

Hab. Mt. Elgon, Uganda (*C. W. Woodhouse*).

ENNEA NYIKAENSIS, sp. n.

Shell differing from *E. fortidentata* Smith † in its larger and

* Proc. Zool. Soc. Lond. 1899, pp. 580–581, pl. xxxiii. figs. 1, 2.

† Ann. & Mag. Nat. Hist. 1890, vi. p. 162, pl. vi. fig. 6.

much broader form, the crenulation at the suture is also considerably finer, and it also lacks the small parietal denticle of that species.

Alt. 9·25, diam. maj. 6·25 mm.

Aperture : alt. 4, diam. 3·25 mm.

Hab. Nyika Range, Nyassaland.

Ennea fortidentata was described by Mr. E. A. Smith, in the year 1890, from specimens collected by Mr. Last at Mamboia, German East Africa, and in 1897 a number of specimens of an *Ennea* were received at the British Museum from Sir H. H. Johnston which had been collected far to the south on the Nyika Range in Nyassaland *. As the dentition appeared to be nearly identical these specimens were considered to be a variety of *E. fortidentata* and have been regarded as such until the present time. Through the courtesy of Mr. Smith I have now been able to examine both the type specimens of *E. fortidentata* and also the series of shells from Nyassaland, besides, through the kindness of Mr. A. Blayney Percival, a vast number of fairly typical specimens of that species from Mt. Elgon in Uganda, with the result that I am forced to the conclusion that the Nyassaland shells are quite distinct from those collected at Mamboia and more recently on Mt. Elgon.

The type of *E. nyikaensis* is in the British Museum.

ENNEA CAREA, sp. n. (Pl. XXXII. figs. 13, 13 a.)

Shell small, cylindrical, white, smooth, polished, shining; whorls 6, very flat, the last broad; sutures incised, narrowly margined above; columella arched above; aperture irregularly subquadrate, armed with a nodulous, parietal lamella, two divergent lamellæ on the columella and a bifurcate lamella on the upper margin of the outer lip; labrum whitish, thickened, scarcely reflexed.

Alt. 3·25, diam. maj. 75 mm.

Hab. Gazi, British East Africa (*Robin Kemp*).

ENNEA COPIOSA, sp. n. (Pl. XXXII. figs. 16, 16 a.)

Shell cylindrically ovate, with very obtuse apex, thin, transparent, polished, shining, vitreous, whitish; whorls $6\frac{1}{2}$, the first four and a half regularly increasing in length and breadth, the penultimate increasing proportionately in length but not much in breadth, the last whorl increasing in length but considerably diminishing in breadth, marked only on the upper whorls with oblique, transverse striae, the latter half of the last whorl and the base of the shell being finely costulate, especially round the umbilical area; suture impressed, narrowly margined below and showing occasional traces of nodulous crenellation; umbilical depression ovate, moderately open and deep; columella very

* Proc. Zool. Soc. London, 1899, p. 581.

slightly, obliquely descending, broadly, outwardly expanded, vitreous, both this and the labrum, which is also rather broadly, outwardly expanded and narrowly reflexed at the edge, showing the white laminiferous, somewhat irregular growth-periods; aperture irregularly subquadrate, armed with an erect sickle-shaped parietal lamella, which starts from the upper margin of the labrum and proceeds downwards in an oblique direction for some distance, when it terminates in a broad, shallow, cup-like projection; two glassy, lamella-like teeth on the inner margin of the labrum, of which the lower is the larger and is much more quadrate than the upper; a small, interiorly situate, basal denticle; a minute, sharp, thorn-like denticle at the base of the columella, and a triangular, trifid, projecting denticle or lamella on the upper portion of the columella.

Alt. 6, diam. maj. 3·25 mm,

Aperture: alt. 1·5, diam. 1 mm.

Hab. Urguess, British East Africa (*A. Blayney Percival*).

Var. *ROBUSTA*, var. n.

Shell differing from the type in its larger and more cylindrical form and in the stronger and more fully developed apertural armature, though the system remains the same.

Alt. 7·75, diam. maj. 3·75 mm.

Aperture: alt. 1·75, diam. 1·25 mm.

Hab. Larogi Hills, British East Africa, at an altitude of 6000 to 7000 feet (*A. Blayney Percival*).

ENNEA CURVICOLUMELLA, sp. n. (Pl. XXXII. figs. 17, 17 a.)

Shell small, perforate, shortly cylindrical, smooth, shining, vitreous, creamy white; whorls 6, flattish, the first three rather rapidly increasing, the fourth and fifth gradually so, the sixth rather broad in proportion to the remainder; suture impressed, margined below; umbilicus moderately wide and deep; columella descending in an angular curve and excavated at the angle, where, on the inner margin, is developed a coarse, lamelliform protuberance projecting into the interior of the shell; labrum continuous, somewhat expanded and reflexed, bearing two lamelliform plaits (of which the lower is the larger) on the inner margin of the upper portion, and a coarse, slightly curved, erect, parietal lamella above; aperture rather elongately subquadrate.

Alt. 2·75, diam. maj. 1·25 mm.

Hab. Between the Jombene Hills and Nyeri, British East Africa (*Robin Kemp*).

ENNEA DECUSSATULA, sp. n. (Pl. XXXIII. figs. 1, 1 a.)

Shell cylindrically ovate, thin, cream-coloured; whorls 7, the first five regularly increasing, the sixth long in proportion to those above, the seventh also long, but diminishing in breadth and bistrangulate just behind the labrum, sculptured with rather

coarse, oblique, transverse costulae, and minutely, spirally malleated so as to present a slightly decussate appearance; suture incised, strongly crenellated by the terminations of the transverse costulae; umbilical area appearing as a narrow and shallow depression; columella slightly oblique; labrum white, narrowly expanded and reflexed, the margins distant; aperture subrhomboidal, armed with a single, erect, nearly vertically descending, parietal lamella, a small denticle and a somewhat weak lamella on the inner side of the outer lip, a well-developed basal denticle at the base, and a broad squarish shelf-like projection on the columella bearing a central depression.

Alt. 11·75, diam. maj. 5·5 mm.

Aperture: alt. 4, diam. 2·5 mm.

Hab. Kigezi, extreme S.W. Uganda, at an altitude of 7000 feet (*Robin Kemp*).

ENNEA DISSEMINATA, sp. n. (Pl. XXXIII. figs. 2, 2 a.)

Shell small, rather shortly cylindrical, whitish, slightly polished; whorls 7, the third, fourth, and fifth somewhat convex, the sixth and seventh flattish, sculptured, especially on the later whorls, with indistinct, oblique, transverse costulae; suture impressed, rather distantly crenellated by the terminations of the transverse costulae; umbilicus reduced to a mere fissure; columella curved, extending above into a narrow, but thickish, parietal callus; labrum white, narrowly reflexed; aperture subquadrate, armed with a short, erect, parietal lamella, a broad, subbitifid, tooth-like projection on the inner margin of the outer lip, a small basal denticle at the foot of the columella, and above this a broad, rounded projection, very interiorly situate.

Alt. 4·25, diam. maj. 2 mm.

Aperture: alt. ·75, diam. ·5 mm.

Hab. Near Lake Kivu (type specimen); also between Lake Mutanda and the region between that lake and Lake Kivu (*Robin Kemp*).

ENNEA EUSSOENSIS, sp. n. (Pl. XXXIII. figs. 4, 4 a.)

Shell ovately cylindrical with obtuse apex, scarcely rimate, moderately solid, shining, dark cream-colour; whorls 6, the first three rapidly, the remainder regularly, increasing, slightly convex, smooth but for lines of growth; suture impressed; columella white, rather broadly, outwardly expanded; labrum white, expanded, slightly reflexed; aperture rather broad and short, armed with a coarse, oblique, parietal lamella situated on the right-hand side, a short, tooth-like lamella on the inner margin of the outer lip and a small lamella situated on the median region of the columella.

Alt. 5·5, diam. maj. 2·5 mm.

Aperture: alt. 1·5, diam. 1·25 mm.

Hab. Eusso Nyiro, British East Africa (*Robin Kemp*).

ENNEA FOVEOLATA, sp. n. (Pl. XXXIII. figs. 5, 5 a.)

Shell small, cylindrical, cream-coloured, polished; whorls 6, rather flat, plicate at the suture, otherwise smooth with the exception of the latter portion of the last whorl which is plicate throughout, last whorl bearing three hollows or dents just behind the peristome; suture impressed; columella produced internally into a very broad, squarish, shelf-like projection; aperture somewhat square, armed with a small, rounded denticle immediately below the shelf-like columella, a broad projection inside the outer lip, a small denticle above this and a curved, erect, parietal lamella; labrum white, expanded, reflexed.

Alt. 4·25, diam. maj. 1·5 mm.

Aperture: alt. .75, diam. .75 (nearly) mm.

Hab. Gazi, British East Africa (*Robin Kemp*).

ENNEA FUNEREA, sp. n. (Pl. XXXIII. figs. 6, 6 a.)

Shell cylindrical, rather solid, somewhat shining, covered with a dark blackish-brown periostracum; whorls 7, the first rapidly, the last three moderately increasing, flattish, sculptured with regular, very oblique, transverse costulae; suture impressed; columella vertically descending, outwardly broadened and expanded, greyish white; labrum slightly granular, also greyish white and outwardly expanded with reflexed margin; aperture subquadrate, bearing a coarse, erect, parietal lamella, two slightly distant lamellæ on the inner margin of the outer lip, of which the lower is the larger, a moderately sized, basal, tooth-like lamella, and a very coarse and blunt, almost bifurcate lamella on the columella.

Alt. 6, diam. maj. 2·75 (nearly) mm.

Aperture: alt. 1·75, diam. .75 mm.

Hab. Chanler Falls, Eusso Nyiro River, British East Africa (*Robin Kemp*).

Var. *LAEVIS*, var. n.

Shell differing from the typical form in being almost destitute of the transverse sculpture.

Alt. (of type specimen) 7, diam. maj. 2·75 mm.

Aperture: alt. 2, diam. .75 mm.

Hab. Between the Eusso Nyiro River and Mount Marsabit, British East Africa (*A. Blayney Percival*).

Though the series of the typical form collected by Mr. Kemp at the Chanler Falls scarcely varies in size, the present variety shows enormous differences, as below:—

Largest specimen: alt. 8·5, diam. maj. 3·25; aperture: alt. 2, diam. .75 mm.

Smallest specimen: alt. 4·75, diam. maj. 2·5; aperture: alt. 1·5, diam. .75 mm.

ENNEA HECTOR, sp. n. (Pl. XXXIII. fig. 7.)

Shell large, ovately cylindrical, rather thin, smooth but for

lines of growth, somewhat shining, creamy white; whorls $7\frac{1}{2}$, the first five regularly, the remainder rapidly, increasing, the last contracted below; suture impressed; umbilicus moderately narrow; columella obliquely descending, white, reflexed, diffused above into a lightish callus which joins the upper margin of the labrum; labrum white, sinuous, expanded and reflexed, especially in the basal region; aperture irregularly subquadrate, armed with an erect, somewhat bent, oblique, parietal lamella slightly broadening below, a group of three denticles on the inner margin of the labrum, of which the middle one is the largest and the lowest the smallest, a small, triangular, basal denticle and a strong curved lamelliform projection about halfway up the columella.

Alt. 18·25, diam. maj. 9 mm.

Aperture: alt. 6, diam. 4·25 mm.

Hab. Between the Jombene Hills and Nyeri, British East Africa (type) (*Robin Kemp*).

A very handsome species which it would be difficult to confound with any other as yet recorded from the region in which it occurs; specimens were also sparingly found by Mr. Kemp on the Jombene Hills at an altitude of 6000 feet and at Mweru.

ENNEA INGEZIENSIS, sp. n. (Pl. XXXIII. figs. 9, 9a.)

Shell small, ovately cylindrical, cream-coloured, somewhat shining; whorls 7, the first five regularly increasing, the last two longer but narrower than the fifth, the last deeply strangulate just behind the labrum, marked with obsolete, oblique, transverse riblets; suture well impressed, strongly crenellated by the terminations of the obsolete, transverse riblets; umbilical area presenting a rather deep depression; columella descending in a somewhat angular curve and developed into a broad, shelf-like projection well within; labrum white, expanded and narrowly reflexed, the margins joined by a well-defined, parietal callus; aperture subrectangular, armed with a coarse, erect, somewhat curved, parietal lamella, a large, squarish, tooth-like projection on the labrum corresponding to, and formed by, the deep strangulation on the last whorl, a small, triangular denticle at the base of the columella, above which and very interiorly situate is a broad, shelf-like projection.

Alt. 4·5, diam. maj. 2 mm.

Aperture: alt. 1·25, diam. 1 mm.

Hab. Ingezi, Mfumburu Mountains, extreme S.W. Uganda; also from Kigezi in the same region at an altitude of 6000 feet (*Robin Kemp*).

Var. PUSILLA, var. n.

Shell much smaller than the typical form, with one whorl less, which gives to it a more cylindrical appearance; the columella also descends more vertically than is the case with the type.

Alt. 3·25 (nearly), diam. maj. 1·5 (nearly) mm.

Hab. Between Mbarara and Kigezi, extreme S.W. Uganda (*Robin Kemp*).

Var. *MBARARAENSIS*, var. n.

Shell smaller than the typical form and proportionately shorter, with one whorl less, the denticle at the base of the columella is also removed to a position considerably higher up and almost overhanging the internal, shelf-like projection.

Alt. 3·5 (nearly), diam. maj. 1·75 mm.

Aperture: alt. 1 (nearly), diam. .75 mm.

Hab. Between Mbarara and Masaka, extreme S.W. Uganda (*Robin Kemp*).

ENNEA INSULSA, sp. n. (Pl. XXXIII. figs. 13, 13 a.)

Shell elongately ovate, very minute, cream-coloured; whorls $4\frac{1}{2}$, very convex, sculptured with oblique, transverse riblets, the last ascending in front; suture deeply impressed; aperture subquadrate, armed with a parietal lamella bearing a small, internal, erect denticle towards the base of the outer lip and an internal lamella on the columella; labrum white, outwardly expanded, continuous.

Alt. 1·75, diam. maj. .75 mm.

Hab. Gazi, British East Africa (*Robin Kemp*).

ENNEA INTRADENTATA, sp. n. (Pl. XXXIII. figs. 14, 14 a.)

Shell small, cylindrical, yellowish white; whorls $6\frac{1}{2}$, the first two and a half rapidly, the remainder scarcely, increasing, rather flat, smooth; suture impressed; umbilical area forming a shallow depression; columella descending obliquely, notched above, bulging inwardly below; labrum white, sinuous, narrowly reflexed; aperture irregularly, somewhat elongately subquadrate, armed with an almost vertical, parietal lamella, an upwardly directed, tooth-like lamella on the outer lip, below which and very interiorly situate occurs a nodulous lamella, two converging, deeply situate, broad, basal denticles, and two broad lamellæ also very interiorly situate on the columella, of which the uppermost is the stronger.

Alt. 3·5, diam. maj. 1·25 mm.

Hab. Jombene Hills, British East Africa, at an altitude of 6000 feet; a single specimen was also taken on the route between the Jombene Hills and Nyeri (*Robin Kemp*).

ENNEA IRIDESCENTS, sp. n. (Pl. XXXIII. figs. 12, 12 a.)

Shell rather elongately cylindrical, thin, semitransparent, whitish, polished, shining, slightly iridescent; whorls 7, the first four regularly increasing, the remainder increasing in length but slightly diminishing in breadth, marked with coarse, oblique growth-lines; suture impressed; umbilical area presenting the appearance of a rather broad and shallow depression; columella almost vertically descending; labrum rather broadly expanded and reflexed; aperture subquadrilateral, armed with a small, rather interiorly situate denticle and a coarse, erect lamella on the parietal wall, a projection on the inner margin of the outer lip, and immediately below this and in the interior of the shell

a stout, squarish denticle, a broad, well-developed, basal denticle well within the aperture, and a bifid lamella on the columella, the upper arm of which is much the coarser.

Alt. 4, diam. maj. 1·5 mm.

Aperture : alt. ·75, diam. ·5 mm.

Hab. Near Kigezi, extreme S.W. Uganda (*Robin Kemp*).

Var. CURTA, var. n.

Shell shorter and proportionately a little broader, with one whorl less ; the large, parietal lamella is less strongly developed and the basal denticle more strongly so than in the typical form.

Alt. 3·5 (nearly), diam. maj. 1·5 (nearly) mm.

Aperture : alt. ·75, diam. ·5 mm.

Hab. Burunga, Mount Mikeno, Belgian Congo, at an altitude of 6000 feet (*Robin Kemp*).

ENNEA BURUNGAENSIS, sp. n. (Pl. XXXII. figs. 12, 12 a.)

Shell differing from *E. iridescent* in its shorter, broader, and rather less cylindrical form, in being obsoletely plicate on the upper whorls, and in having the suture strongly crenellate ; the aperture is ovate and lacks the small, interiorly situate, parietal denticle of that species, the projection on the inner margin of the outer lip is much more square in shape, stronger and more marked, and the denticle below is, in the present form, developed into a long, curved, erect lamella ; moreover there are two large basal denticles, the lower being interiorly situate, instead of the single basal denticle of *E. iridescent*, and the bifid lamella on the columella of that species is replaced by a broad, shelf-like projection.

Alt. 4·25, diam. maj. 1·75 mm.

Aperture : alt. ·75, diam. ·5 mm.

Hab. Burunga, Mount Mikeno, Belgian Congo, at an altitude of 6000 feet (*Robin Kemp*).

ENNEA KENIANA Preston, var. PARVULA, var. n.

Smaller than the typical form * from Mount Kenia.

Alt. 2·5, diam. maj. 1·5 mm.

Hab. Between the Jombene Hills and Nyeri, British East Africa (*Robin Kemp*).

Var. INTERMEDIA, var. n.

Intermediate between the typical form and var. *parvula*.

Alt. 3 (about), diam. maj. 1·75 mm.

Hab. Jombene Hills, British East Africa, at an altitude of 6000 feet (*Robin Kemp*).

Both the above varieties appear to be well-marked local races, the species seeming to become more stunted in the lower country.

* Ann. Mag. Nat. Hist. vol. vii. 1911, p. 464, pl. xi. fig. 3.

ENNEA ABERDARENSIS, sp. n. (Pl. XXXII. figs. 6, 6 a.)

Shell differing from *E. keniana* Preston* in its more ovate form and much smaller size, in having but 6 whorls, a more curved columella, more regularly rectangular aperture, and proportionately stronger armature, though the arrangement of the apertural lamellæ is quite similar.

Alt. 2·75, diam. maj. 2·75 (nearly) mm.

Hab. Mt. Kenangop, Aberdare Range, British East Africa (*Robin Kemp*).

ENNEA KIGEZIENSIS, sp. n. (Pl. XXXIV. figs. 2, 2 a.)

Shell small, shortly cylindrical, whitish, somewhat shining; whorls $6\frac{1}{2}$, the first four and a half regularly increasing, the last two regularly increasing in length, but very slightly diminishing in breadth, marked with growth-lines, otherwise smooth, except in the subsutural region, where the shell is coarsely plicate; suture well impressed; umbilicus laterally compressed into a fissure; columella somewhat curved, outwardly expanded; labrum white, expanded outwards and reflexed, the margins converging; aperture subquadrilateral, armed with a single, rather coarse, erect and vertical, parietal lamella, a coarse, nodulous denticle on the inner margin of the outer lip, below which and very interiorly situate occurs a broadly triangular lamella, and a broad, interiorly situate projection on the columella ending in three distant, pointed denticles.

Alt. 3 (about), diam. maj. 1·5 mm.

Hab. Kigezi, extreme S.W. Uganda (*Robin Kemp*).

ENNEA LAQUEUS, sp. n. (Pl. XXXIV. figs. 5, 5 a.)

Shell rather small, ovately cylindrical, solid, whitish; whorls $6\frac{1}{2}$, the first two and a half regularly increasing, the third much larger, the antepenultimate proportionately so, the penultimate increasing in length but scarcely in breadth, and the last also increasing in length but diminishing in breadth, the apical whorls faintly and finely, decussately sculptured with transverse and spiral striæ, the remaining whorls sculptured with moderately fine, closely-set, oblique costulæ, which become finer and still more closely set in the strangulated area just behind the labrum, and where also traces of microscopic, spiral striæ are visible; suture well impressed; umbilical area represented by an obliquely elongate depression; columella descending in a curve and bearing, very internally, a broad, sloping, shelf-like projection; labrum white, porcellanous, continuous, outwardly expanded and reflexed, callously flattened against the parietal wall; aperture irregularly ovate, bearing an erect, parietal lamella, and a projection on the upper portion of the outer lip which bears two small, fine lamellæ above and a coarser one below, the parietal lamellæ fitting between the two former; at the base of the aperture, somewhat

* Ann. Mag. Nat. Hist. vol. vii. 1911, p. 464, pl. xi. fig. 3.

inferiorly situate and a little to one side, appears a moderately small denticle.

Alt. 4 (nearly), diam. maj. 2 mm.

Aperture: alt. .75, diam. .5 mm.

Hab. Jombene Hills, British East Africa, at an altitude of 4000 feet (*A. Blayney Percival*).

A very remarkable species, which, apart from the decussate sculpture of the apical whorls, visible only by the aid of a microscope, is easily separable from hitherto-described species of the group by the interlocking of the parietal lamella with those on the projection situated just within the aperture on the outer lip.

Var. HERCULES, var. n.

Differing from the typical form in its much larger size, coarser sculpture, and rather more obtuse apex.

Alt. 6.25, diam. maj. 3 mm.

Aperture: alt. 1.75, diam. 1.25 mm.

Hab. Urgess, British East Africa, at an altitude of 6000 feet (*A. Blayney Percival*).

ENNEA CLAUSTRUM, sp. n. (Pl. XXXII. figs. 14, 14 a.)

Shell allied to *E. laqueus*, but larger, more cylindrical and less ovate, it has half a whorl more and is more strongly, transversely costulate on all but the apical whorls; the columella descends in a much stronger curve, and instead of the broad, internal, shelf-like projection, which in the present species is reduced to a very slight protuberance, there is, very internally situated, a strong, curved lamella on the outer wall.

Alt. 4.75, diam. maj. 2 mm.

Aperture: alt. .75, diam. .75 mm.

Hab. Between the Laikipia Plateau and the Eusso Nyiro River, British East Africa (*A. Blayney Percival*).

ENNEA LIMA, sp. n. (Pl. XXXIV. figs. 6-6 b.)

Shell ovately cylindrical, white, somewhat shining; whorls 7, the first very small, somewhat flattened, the second rather large in proportion, the third, fourth, and fifth regularly increasing in length and breadth, the sixth and seventh increasing in length, but diminishing slightly in breadth, the apical whorls smooth, polished, the remainder rather curiously, coarsely, cancellately sculptured with spiral sulci, the interstices being crossed by short, closely-set ridges, which develop on the latter half of the last whorl and on the base of the shell into fine transverse costulae; suture impressed, narrowly margined below with white; umbilical depression wide and moderately deep, finely, transversely costulate; columella white, porcellanous, broadly and somewhat erectly, outwardly expanded, slightly obliquely descending, diffused into a white, rather coarsely costulate, well-defined, parietal callus which reaches to the upper margin of the

labrum; labrum white, outwardly expanded and reflexed below; aperture subquadrate, armed with a coarse, oblique, parietal lamella, two coarse, broad, projecting denticles on the inner margin of the labrum, of which the lower is the larger, a small, slightly interiorly situate, basal denticle, a minute denticle at the base of the columella, and a broad, bifurcate, projecting lamella on its median part.

Alt. 6·25, diam. maj. 3 mm.

Aperture: alt. 2, diam. 1·25 mm.

Hab. Urguress, British East Africa (*A. Blayney Percival*).

ENNEA MALASANGIENSIS, sp. n. (Pl. XXXIV. figs. 7, 7 a.)

Shell cylindrical, yellowish white, somewhat polished; whorls 6, the first very small, the second and third proportionately large, regularly increasing, the remainder increasing in length but not in breadth, moderately convex, having a somewhat weathered appearance; suture deeply impressed; umbilicus rather wide, shallow; columella vertically descending, broadly expanded; labrum broadly expanded and reflexed below, continued along the parietal wall; aperture subrectangular, armed with a small, interiorly situate denticle, and a strong, curved, parietal lamella, a broad, squarish projection on the inner margin of the outer lip, an interiorly situate, basal denticle, and a broad, bifurcate projection on the columella, of which the upper bifurcation is the stronger.

Alt. 3·25 (nearly), diam. maj. 1·25 mm.

Aperture: alt. .75, diam. .5 mm.

Hab. Malasangi, S.W. Uganda (*Robin Kemp*).

ENNEA MASAKAENSIS, sp. n. (Pl. XXXIV. figs. 9, 9 a.)

Shell small, acuminate ovate, in dead condition yellowish; whorls 6, the first five regularly increasing, the sixth increasing in length but slightly decreasing in breadth, sculptured with somewhat distant, vertical, transverse costulæ; suture impressed; umbilicus reduced to a narrow and shallow depression; columella obliquely descending; labrum continuous, rather broadly expanded, reflexed; aperture subquadrate, armed with a parietal lamella and a broad denticle on the inner margin of the outer lip.

Alt. 4, diam. maj. 1·75 mm.

Aperture: alt. .75, diam. .75 mm.

Hab. Between Masaka and Entebbe, extreme S.W. Uganda (*Robin Kemp*).

ENNEA MIKENOENSIS, sp. n. (Pl. XXXIV. figs. 10, 10 a.)

Shell cylindrically ovate, dark yellowish white; whorls 8, the first six regularly increasing, the last two increasing in length but very slightly decreasing in breadth, sculptured with rather coarse, oblique costulæ; suture impressed; umbilicus narrow, deep, rapidly widening below; columella somewhat vertically

descending; labrum continuous, expanded and slightly reflexed, notched on its outer margin; aperture subrectangular, armed with one very small, somewhat interiorly situate, parietal denticle, and one coarse, curved above and straightly descending, parietal lamella, a coarse, bifurcate denticle on the inner margin of the labrum, the upper bifurcation being much smaller than the lower, a very interiorly situate basal tooth and a coarse, squarish lamella-like tooth on the columella.

Alt. 4, diam. maj. 2·25 mm.

Aperture: alt. 1, diam. ·75 mm.

Hab. Burunga, Mount Mikeno, Belgian Congo, at an altitude of 6000 feet (*Robin Kemp*).

ENNEA MONTICOLA, sp. n. (Pl. XXXIV. figs. 12, 12 a.)

Shell allied to *E. commoda* Smith * from the Mau Escarpment, E. Uganda, but smaller, of a more cylindrical shape, with finer transverse sculpture and having one whorl more; the lamella on the outer lip is also much more strongly bifurcate than in *E. commoda*, and there is, in the present species, no internal basal denticle immediately below it.

Alt. 3·75, diam. maj. 2 mm.

Aperture: alt. ·75, diam. ·5 mm.

Hab. Larogi Hills, British East Africa, at an altitude of 6000–7000 feet (*A. Blayney Percival*).

ENNEA MWERUENSIS, sp. n. (Pl. XXXIV. figs. 14, 14 a.)

Shell rimate, ovately cylindrical, shining, whitish; whorls 7 the first four regularly, the remainder rather rapidly increasing, flattish, the last ascending in front, sculptured with indistinct, oblique, transverse striae, which are more apparent in the subsutural region and become very marked on the base of the shell; suture impressed, scarcely crenellate; umbilicus reduced to a narrow fissure; columella obliquely descending, bulging inwardly and slightly, erectly, outwardly reflexed; labrum reflexed, expanded, especially on the side opposite to the columella; aperture almost irregularly triangular with rounded base, armed with an erect, oblique, parietal lamella, a projecting, lamelliform denticle on the inner margin of the outer lip and two denticles, one situate at the base of, and the other about halfway up, the columella.

Alt. 7, diam. maj. 3·5 mm.

Aperture: alt. 2·5, diam. 2 mm.

Hab. Mweru, British East Africa (type); also found on the Jombene Hills at an altitude of 6000 feet (*Robin Kemp*).

It may be well here to point out that the village of Mweru above mentioned should not be confounded with the well-known Lake of the same name situated far to the south on the borders of the Congo State and Northern Rhodesia.

* J. Conch., Leeds, x, p. 315, pl. iv. fig. 9.

ENNEA NAIVASHAENSIS Preston*, var. **ELGONENSIS**, var. n.

Shell even more cylindrical than the typical form, with more closely set and more pronounced transverse riblets, the aperture also, through not being contracted at the base, has a less triangular appearance.

Alt. 1·75, diam. maj. 1 mm.

Hab. Mt. Elgon, Uganda (*C. W. Woodhouse*).

ENNEA MUTANDAENSIS, sp. n. (Pl. XXXIV. figs. 13, 13 a.)

Shell differing from *E. naivashaensis* Preston, from Naivasha, British East Africa, in its darker colour, more cylindrical form, less convex and rather longer whorls, and in the broader and more basally rounded aperture.

Alt. 2, diam. maj. 1 mm.

Hab. Between Lake Mutanda and Lake Kivu (*Robin Kemp*).

ENNEA NYIROENSIS, sp. n. (Pl. XXXV. figs. 1, 1 a.)

Shell small, moderately solid, ovately cylindrical, yellowish; whorls 6, the first four convex, regularly increasing, the fifth less convex and only slightly increasing in breadth, the sixth somewhat decreasing in breadth, sculptured with fine, very closely-set, rather oblique, transverse riblets; suture impressed; umbilical area presenting the appearance of an elongate, strangulate depression; columella white, very obliquely descending, outwardly expanded, extending above into a well-defined, parietal callus which reaches the upper margin of the labrum; labrum white, narrowly expanded and narrowly reflexed, except above, where it is somewhat contracted; aperture very obliquely subquadrate, armed with a strong, curved, parietal lamella, a broad, bifid, tooth-like projection rather interiorly situate on the inner margin of the outer lip, and a very interiorly situated, lamellalike, basal denticle.

Alt. 4, diam. maj. 2 mm.

Aperture: alt. 1, diam. .5 mm.

Hab. Mt. Nyiro, to the south of Lake Rudolph, at an altitude of 8300 feet (*A. Blayney Percival*).

ENNEA OPTATA Preston, var. **OBESA**, var. n. (Pl. XXXV. figs. 3, 3 a.)

Shell much broader and more ovate than the typical form † and with half a whorl less; moreover, the lower denticle below the lamella on the inner margin of the labrum is almost obsolete.

Alt. 12, diam. maj. 6·5 mm.

Aperture: alt. 3·5, diam. 2·25 mm.

Hab. Mt. Kenangop, Aberdare Range, British East Africa (*Robin Kemp*).

* Rev. Zool. Africaine, Brussels, 1911, vol. i. p. 219, pl. xi. fig. 3.

† Ann. Mag. Nat. Hist. 1911, vii. pp. 464-465, pl. xi. fig. 4.

Var. MAJUSCULA, var. n. (Pl. XXXV. figs. 2, 2a.)

Shell much larger than either the typical form or the var. *obesa*; it is also more cylindrical than the latter, though the dentition agrees perfectly with that variety.

Alt. 13·75, diam. maj. 6·5 mm.

Aperture: alt. 3·75, diam. 3 mm.

Hab. Mt. Kenangop, Aberdare Range, British East Africa (*Robin Kemp*).

The typical series from Mt. Kenia was collected in a dead condition and appeared, though polished and shining, to be pure white; both the present varieties were collected alive and are of an olive-greenish hue, which is also doubtless the normal colour of the typical form.

ENNEA PAPYRACEA, sp. n. (Pl. XXXV. figs. 4, 4a.)

Shell ovately cylindrical, white, very thin; whorls 8, not very convex, the first seven regularly increasing, the eighth narrower, sculptured with rather coarse, very oblique, transverse riblets, and, on the last whorl, with fine, rather indistinct, spiral striae; suture very lightly impressed, strongly crenellated by the termination of the transverse riblets; umbilical area presenting the appearance of a very shallow, elongate fissure; columella somewhat vertically descending, extending above into a thin, parietal callus; labrum white, narrowly reflexed; aperture subquadrate, armed with a parietal lamella, a small denticle, and below this a large erectly squarish denticle just within the outer lip, a small basal denticle and a broad projection on the columella terminating in three denticles.

Alt. 11·75, diam. maj. 6 mm.

Aperture: alt. 3·5, diam. 2·25 mm.

Hab. Near Lake Kivu, Belgian Congo (*Robin Kemp*).

ENNEA PERGRATA, sp. n. (Pl. XXXV. figs. 6, 6a.)

Shell rimate, rather large, elongately cylindrical, semitransparent, whitish, shining; whorls 8, not very convex, the first four regularly increasing, the remainder slowly increasing in length but not in breadth, sculptured with irregular, very oblique, transverse plicæ, which are more noticeable in the sutural region; suture impressed, coarsely crenellate below by the terminations of the transverse plicæ; umbilicus moderately narrow; labrum white, shining, reflexed and outwardly expanded, especially below; columella vertically descending, widely reflexed above, narrowing below, bearing a coarse, projecting denticle in the median region; aperture subquadrate, armed with a coarse, erect, vertical, parietal plait, two denticles on the inner surface of the outer lip, of which the uppermost is the smaller, and a broad denticle at the base.

Alt. 12·5, diam. maj. 4·25 mm.

Aperture: alt. 3·5, diam. 1·5 mm.

Hab. Mt. Elgon, Uganda (*C. W. Woodhouse*).

An extraordinarily cylindrical form which does not appear, so far as is at present known, to have any close ally in East or East Central Africa.

ENNEA PERVITREA, sp. n. (Pl. XXXV. figs. 8, 8a.)

Shell cylindrical, polished, shining, glassy, transparent whitish; whorls $7\frac{1}{2}$, the first four and a half regularly increasing in breadth and length, the last three increasing in length but not in breadth, the last rapidly ascending in front, quite smooth but for occasional growth-markings; suture very slightly impressed, narrowly margined below; umbilicus very narrow, deep; columella obliquely descending, spreading above into a thin, somewhat extended, sinuously margined, parietal callus; labrum white, outwardly expanded and reflexed, especially below; aperture semiovate, armed with a strong, curved, parietal lamella, a moderately stout denticle on the inner margin of the outer lip, and a broad, but less pronounced, denticle on the columella.

Alt. 6·75, diam. maj. 3·25 mm.

Aperture: alt. 1·75, diam. 1·25 mm.

Hab. Forests to the north of Mt. Kenia, British East Africa (*A. Blayney Percival*).

ENNEA JOMBENEËNSIS, sp. n. (Pl. XXXIII. figs. 8, 8a.)

Shell allied to *E. pilula** Preston from Mt. Kenia, but of a thinner texture, lighter colour, more cylindrical form, and having a less outwardly expanded columella and less strongly developed labrum; nevertheless the subparietal lamella is more strongly marked, and beside it occurs, on the parietal wall, a small, vertical denticle, which is quite lacking in *E. pilula*; in addition to this the present species possesses an extra basal lamella.

Alt. 12·25, diam. maj. 6·5 mm.

Aperture: alt. 2·75, diam. 1·5 mm.

Hab. Jombene Hills, British East Africa, at an altitude of 6000 feet (type); also taken at Mweru (*Robin Kemp*).

ENNEA POLLONERÆ, sp. n. (Pl. XXXV. figs. 9, 9a.)

Shell cylindrically rectangular, whitish, somewhat solid; whorls $6\frac{1}{2}$, the first two flattened above, the remainder flattened laterally, the upper whorls regularly increasing, the last two decreasing in breadth, sculptured with fine, oblique, transverse costulae; suture almost linear, crenellated by the terminations of the transverse costulae; umbilical area marked by a shallow, elongate depression; columella descending in a curve, extending above into a well-defined, white, parietal callus which reaches the upper margin of the labrum; labrum white, slightly polished, expanded and reflexed; aperture subcircular, armed with a coarse, sinuously curved, parietal lamella extending far into the interior of the

* Ann. Mag. Nat. Hist. 1911, vii. p. 465, pl. xi. fig. 5.

shell, two elongate lamellæ on the outer wall, the upper of which terminates in a coarse, nodulous denticle on the inner margin of the upper portion of the labrum and a broad, bidenticulate projection on the columella.

Alt. 12, diam. maj. 6·75 mm.

Aperture: alt. 2·5, diam. 2 mm.

Hab. Lake Kivu, Belgian Congo (*Robin Kemp*).

ENNEA PRETIOSA Preston, var. **NYIROENSIS**, var. n.

Shell differing from the typical form * from Mt. Kenia and the surrounding region in its larger size and more rounded shape; it also has one whorl more, a shallower suture, and more circular aperture; the last whorl is proportionately narrower towards the base and the transverse costulæ in the large series before me are less pronounced.

Alt. 5·75 (nearly), diam. maj. 3·25 mm.

Aperture: alt. 1·25, diam. 1·25 mm.

Hab. Mt. Nyiro, to the south of Lake Rudolph, at an altitude of 8300 feet (*A. Blayney Percival*).

ENNEA ADJACENS, sp. n. (Pl. XXXII. figs. 8, 8 a.)

Shell differing from *E. pretiosa* Preston from Mt. Kenia in its broader and more solid form, rather more circular aperture, and in the transverse sculpture, which, in the present species, is much finer, rather more oblique, and *very much more closely set* except on the latter half of the last whorl; the labrum, which is continuous, is also more broadly outwardly expanded than in *E. pretiosa*.

Alt. 5, diam. maj. 3 mm.

Aperture: alt. .75, diam. .5 mm.

Hab. Between the Jombene Hills and Nyeri, British East Africa (*Robin Kemp*).

ENNEA SPATIUM, sp. n. (Pl. XXXV. figs. 12, 12 a.)

Shell allied to *E. pretiosa*, but differing from that species in its much more distant, transverse costulæ, which are also much less numerous and placed at about twice the distance apart from one another than is the case with that species.

Alt. 4·25, diam. maj. 2·75 mm.

Aperture: alt. .75, diam. .75 mm.

Hab. Larogi Hills, British East Africa, at an altitude of 6000–7000 feet (*A. Blayney Percival*).

ENNEA MIRIFICA, sp. n. (Pl. XXXIV. figs. 11, 11 a.)

Shell allied to *E. pretiosa*, but considerably broader with whorls angled above, the transverse costulæ are more erect except in the subsutural region and are exaggerated into knife-

* Ann. Mag. Nat. Hist. 1911, vii. pp. 465–466, pl. xi. fig. 6.

like projections at the angle of the whorls ; the spaces between the costulae are quite smooth and glassy ; the aperture is obliquely elliptical, and the parietal lamella is larger, broader, and more projecting, especially above ; the basal denticle is almost obsolete and the columella is devoid of armature.

Alt. 4·25, diam. maj. 3 mm.

Aperture : alt. 1, diam. ·5 mm.

Hab. Mt. Nyiro, to the south of Lake Rudolph, at an altitude of 8300 feet (*A. Blayney Percival*).

ENNEA RENIFORMIS, sp. n. (Pl. XXXV. fig. 11.)

Shell perforate, ovately cylindrical, yellowish white ; whorls 6, the first four regularly increasing, the next two increasing in length but not in breadth, the last ascending considerably in front, sculptured with coarse, oblique, transverse plicæ which are more noticeable in the subsutural region ; suture impressed, coarsely serrated by the terminations of the transverse plicæ and considerably overhung in the latter half of the shell by the whorl above ; umbilicus rather wide, deep ; columella obliquely descending above, sharply curved below, extending into a thick, somewhat well-defined, parietal callus, which reaches the lip above and gives the appearance of a continuous labrum ; labrum white, sinuous, narrowly expanded and reflexed ; aperture reniform, bearing a single short, oblique, parietal plait and a denticle on the inner surface of the outer lip in the median part.

Alt. 6·5, diam. maj. (including the aperture) 4·5 mm.

Aperture : alt. 2·25, diam. 1 mm.

Hab. Mt. Elgon, Uganda (*C. W. Woodhouse*).

A curious species, easily recognizable by the rather large umbilicus and ascending last whorl, but especially by the kidney-shaped aperture.

ENNEA SAVIASSIMA, sp. n. (Pl. XXXV. fig. 13.)

Shell imperforate, cylindrical, thin, transparent, cream-coloured, polished, shining ; whorls 8, smooth, the first five regularly increasing, the sixth increasing in length but little in breadth, the last two flattish, also increasing in length but decreasing in breadth ; suture very lightly impressed, narrowly margined below ; columella white, rather obliquely descending, somewhat twisted, bearing a plait towards the median region and extending above into a thin, well-defined, parietal callus, which reaches the upper margin of the labrum and bears a short, curved, parietal lamella ; labrum white, thickened, very slightly expanded but not reflexed, bent slightly inwards and thickened towards the middle of the outer margin ; aperture subrhomboidal.

Alt. 8, diam. maj. 3·75 mm.

Aperture : alt. 2·5, diam. 1·25 mm.

Hab. Mt. Nyiro, to the south of Lake Rudolph, at an altitude of 8300 feet (*A. Blayney Percival*).

ENNEA PERCIVALI, sp. n. (Pl. XXXV. figs. 5, 5 a.)

Shell allied to *E. suavissima*, but differing in its much smaller size, proportionately more elongately cylindrical form, more convex lower whorls, and in possessing half a whorl more; it is narrowly perforate, and the columella, which is not twisted, is somewhat broadly expanded above; moreover, the aperture is less rhomboidal in shape than in *E. suavissima*.

Alt. 5·75, diam. maj. 2·5 mm.

Aperture: alt. 1·75, diam. .75 mm.

Hab. Mt. Nyiro, to the south of Lake Rudolph, at an altitude of 8300 feet (*A. Blayney Percival*).

ENNEA VIATORIS, sp. n. (Pl. XXXV. figs. 14, 14 a.)

Shell large, cylindrical, pale yellowish brown; whorls 8, the first five regularly increasing, the sixth increasing very little in breadth, the last two slightly decreasing in breadth, sculptured with closely-set, rather fine, oblique, transverse costulae; suture lightly impressed; perforation narrow, partly concealed by the outward expansion of the columella; columella vertically descending, outwardly expanded; labrum somewhat broadly dilated and narrowly reflexed except near the upper margin where it is rather contracted; aperture subrhomboidal, armed with a coarse, oblique, erect, parietal lamella, two rather weak lamellæ on the inner margin of the outer lip, of which the lower is the coarser, a basal denticle situate well within, and a rather broad, projecting, tooth-like lamella on the columella.

Alt. 12·25, diam. maj. 5·75 mm.

Aperture: alt. 3·5, diam. 2 mm.

Hab. Mt Nyiro, to the south of Lake Rudolph, at an altitude of 8300 feet (*A. Blayney Percival*).

ENNEA SYNGENES, nom. nov. for *Ennea consobrina* Preston, non Ancey.

Mr. J. R. le B. Tomlin having kindly pointed out to me that the above name used by me in the 'Annals and Magazine of Natural History,' vol. vii. 1911, p. 463, is already preoccupied *, I now venture to propose the name "syngenes" as a substitute.

ENNEA (PTYCHOTREMA) KOMBAENSIS, sp. n. (Pl. XXXIV. figs. 4, 4 a.)

Shell cylindrical, moderately solid, yellowish white; whorls 5, the first three regularly increasing, the fourth proportionately much longer, the fifth, though increasing in length, slightly decreasing in breadth, sculptured with somewhat coarse, oblique, transverse plications; suture impressed, crenellated by the terminations of the transverse plicæ; umbilical area represented by a narrow, elongate, shallow depression; labrum continuous, white, porcellanous, outwardly expanded, and, except along the

* 'British Naturalist,' 1892, p. 125.

parietal wall, reflexed; aperture ovate, armed with an elongate, curved, interiorly entering lamella on the parietal wall, a small denticle and below this a very sinuous, internally entering, elongate lamella on the inner margin of the outer lip, a basal, interiorly situate lamella and an oblique, bifid projection on the columella.

Alt. 7, diam. maj. 3·25 mm.

Aperture: alt. 2·25, diam. 1·25 mm.

Hab. Komba, S.W. Uganda (*Robin Kemp*).

EXPLANATION OF THE PLATES.

PLATE XXXII.

- Figs. 1-1 *a.* *Streptaxis desiderata*, sp. n.
 2-2 *a.* " *marsabitensis*, sp. n.
 3-3 *a.* " *urguensis*, sp. n.
 4. " *percivali*, sp. n.
 5. " *woodhousei*, sp. n.
 6-6 *a.* *Ennea aberdarensis*, sp. n.
 7-7 *a.* " *adelpha*, sp. n. (type).
 8-8 *a.* " *adjacens*, sp. n.
 9-9 *a.* " *arthuri*, sp. n.
 10-10 *a.* " *baccata*, sp. n.
 11. " *buccina*, sp. n.
 12-12 *a.* " *burungaeensis*, sp. n.
 13-13 *a.* " *carea*, sp. n.
 14-14 *a.* " *claustrum*, sp. n.
 15-15 *a.* " *coeni*, sp. n.
 16-16 *a.* " *copiosa*, sp. n.
 17-17 *a.* " *curvicolumella*, sp. n.

PLATE XXXIII.

- Figs. 1-1 *a.* *Eunnea decussatula*, sp. n.
 2-2 *a.* " *disseminata*, sp. n.
 3. " *elgonensis*, sp. n.
 4-4 *a.* " *eussoensis*, sp. n.
 5-5 *a.* " *foveolata*, sp. n.
 6-6 *a.* " *funerea*, sp. n.
 7. " *hector*, sp. n.
 8-8 *a.* " *jombeneensis*, sp. n.
 9-9 *a.* " *ingeziensis*, sp. n.
 10. " *ingloria*, sp. n.
 11. " *innocens*, sp. n.
 12-12 *a.* " *iridescent*, sp. n.
 13-13 *a.* " *insulsa*, sp. n.
 14-14 *a.* " *intradentata*, sp. n.

PLATE XXXIV.

- Figs. 1-1 *a.* *Ennea adelpha*, var.
 2-2 *a.* " *kigeiensis*, sp. n.
 3. " *kivuensis*, sp. n.
 4-4 *a.* " (*Ptychotrema*) *kombaensis*, sp. n.
 5-5 *a.* " *laqueus*, sp. n.
 6-6 *b.* " *lima*, sp. n.
 7-7 *a.* " *malasangiensis*, sp. n.
 8. " *margarita*, sp. n.
 9-9 *a.* " *masakaensis*, sp. n.
 10-10 *a.* " *mikenoensis*, sp. n.
 11-11 *a.* " *miriflora*, sp. n.
 12-12 *a.* " *monticola*, sp. n.
 13-13 *a.* " *mutandaensis*, sp. n.
 14-14 *a.* " *mweruensis*, sp. n.

PLATE XXXV.

- Figs. 1-1a. *Ennea nyiroensis*, sp. n.
 2-2a. " *optata* Preston, var. *majuscula*, var. n.
 3-3a. " " " " *obesa*, var. n.
 4-4a. " *papyracea*, sp. n.
 5-5a. " *percivali*, sp. n.
 6-6a. " *pergrata*, sp. n.
 7-7a. " *perturbata*, sp. n.
 8-8a. " *pervitrea*, sp. n.
 9-9a. " *pollonera*, sp. n.
 10. " *rectangularis*, sp. n.
 11. " *reniformis*, sp. n.
 12-12a. " *spatum*, sp. n.
 13. " *suavissima*, sp. n.
 14-14a. " *viatoris*, sp. n.
 15-15a. " *woodhousei*, sp. n.

16. Notes on the Habits of Certain Reptiles in the Lagos District. By W. A. LAMBORN, M.R.C.S.*

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I. *On the Habits of the Lizard Agama colonorum, Daudin, and on Native Superstition in regard to the Chameleon.*

For some two years I have devoted spare time in Nigeria to the pursuit of Entomology, and one of the questions in which I have interested myself has been as to the palatability of Lepidoptera.

To test this various animals have been employed, and one which has been of great service to me is the common West African lizard *Agama colonorum*. This is by far the most abundant lizard in the district—a camp called Oni on the bank of a fresh-water lagoon 70 miles east of Lagos and 10 miles from the sea, and so I have had ample opportunities of making observations as to its habits.

I must express my grateful thanks to Mr. G. A. Boulenger, F.R.S., for advice and for his kind help in identifying the species of the lizards by means of the specimens in the Natural History Museum.

Agamas are found on high ground only, such as is always above flood-level, and in open spaces, and they group together in communities consisting of six or seven adult females headed by a male. I am strongly of opinion that these females look to one lord and master only, and that every such family is to be found day after day in one particular locality. This point might, of

* Communicated by Prof. E. B. POULTON, F.R.S., F.Z.S.

course, have been settled by marking the females, but the difficulty has been that they are particularly wary and hard to catch. I have satisfied myself, however, that any particular male can always be found within the limits of a small area day by day, and that the females keep within the same neighbourhood is indicated by both sexes habitually seeking the same resting place night after night.

During several months of the year 1912 a male lizard invariably slept under the eaves of my bungalow, gaining access thereto by climbing one particular pillar. On one occasion when it sought the usual resting place I drove it down, but it returned a few minutes later. I frightened it off twice again and even then it came back, and finally I allowed it to climb up.

An old female, which I knew well because it had a bulbous stump in the place of its tail, always entered a particular hole in the wall of the bungalow at night-time. The young lizards wander to a far greater extent, not attaching themselves to any particular group, and I do not think that they seek nightly any regular sleeping place.

The male lizard is a strict disciplinarian, and if one of his harem happens to offend him he chases her and endeavours to inflict a bite. The females have in consequence a due respect for him, so much so, that if some one drops a number of butterflies in the vicinity the females, as a rule, wait for the male to take his fill before attempting to satisfy their appetites, and if one of the females does presume to attempt to share the meal, the male becomes so filled with the desire to inflict vengeance that he will desert the prey and chase the offender with the utmost activity, often leaving the other females to test the meal.

The remarkable subservience of the females appears to be connected with the great disparity in the numbers of the sexes. The male's responsibilites seem to be in excess of his capacities, so that the females are forced to resort to various artifices to secure their share of his attentions. This solicitation usually takes the form of running up to the male, elevating the tail in front of him and turning it to one side, but even then he frequently responds by biting the importunate female. If she runs away, however, he will sometimes pursue, and unless she allows herself to be caught too readily, her end may be attained. I am sure that this little manœuvre does act as an incentive to the male.

Previous to the act of pairing, the male mounts the female from one side and supports himself by gripping the neck in his jaws, her tail being raised and deflected to the opposite side. When coupling has been initiated, the male releases the neck of the female and takes up a position more or less at a right angle to her while it is in progress. If disturbed, both of course endeavour to rush away, and the male will often drag the female for a distance of some feet, sometimes up a tree, before uncoupling results. The process usually lasts two or three minutes.

The eggs, in a cluster of three or four, are deposited in the

ground excavated by the female and are then covered with earth. The choice of a situation to the liking of the female seems to be a difficult one, for she will frequently make several burrows without ovipositing in any. These are left open, with the little heap of earth at one side.

As is to be expected, the males are exceedingly combative, and the entry of one into the preserves of another usually leads to a battle. The males eye one another from a distance, raising and lowering the forepart of the body repeatedly at a slow rate. One then approaches a few feet nearer to the other and rests again, watching its adversary, and then after a long wait rushes up from a distance of two or three feet to within a few inches of him. The tail is the offensive weapon, and to bring it into action the males take up a position parallel to each other but head to tail. Each seeks to overcome the other not by a number of strokes but by a single well-directed blow, and there is much manoeuvring with a view to obtaining a favourable position. Many of the blows are ineffective, for the lizards dodge each other very skilfully, but when a blow does get home it may be a powerful one, judging by the resounding smack which follows. After a few such blows one turns tail and the victor pursues him, with the result that a further round may be fought out, though often the loser is simply chased away. The males never are killed in their combats, and I have never seen one male attempt to bite another.

There is more tendency for the females to bite each other, and one frequently sees a large female running open-mouthed at a smaller one, especially if the smaller one happens to have protruding from its mouth a morsel too large to be readily swallowed.

Both males and females will bite when cornered if an attempt be made to handle them.

The lizards are usually insectivorous, but when insects are scarce, as in the dry season, they will not uncommonly eat vegetable matter such as lettuce, tomatoes, and various indigenous fruits.

Their voracity is remarkable. On February 12th, 1912, I dropped no fewer than eighteen of the Pierine butterfly, *Phrisura sylvia*, before a male lizard, and all were consumed within ten minutes.

I have left behind me in Nigeria a snake 10 inches long which had been seized by a lizard of this species. I did not personally see the incident, but on returning to camp after a short absence on June 29th, I was shown the bodies of the snake and lizard, and was told by my colleagues that they had seen the lizard walking backwards dragging the snake by its upper jaw. Still proceeding backwards it began to climb a palm tree, the snake actively wriggling all the time, and it reached a height of six feet. Unfortunately, at this point some barbarian instinct prompted one of the men to throw a stone which injured the lizard so that the snake was released and fell to the ground, where it was despatched.

Incidentally I may say that it is easy to hit a lizard with a stone. They seem unable to judge its flight and make little attempt to dodge it.

If one endeavours to approach them they run off at a rapid rate towards the nearest wall or tree, as they are able to scale a rough perpendicular surface readily.

When on the look-out for prey they mount a stone or other point of vantage whence a more ready view of the neighbourhood can be obtained.

It is of course the common belief among the West Coast natives as it is among country people even in England, that the lizard is a venomous reptile. In connection with this point I have been asked to take this opportunity to communicate with my own facts an observation made by Mr. J. A. de Gaye, F.L.S., Science Master at King's School, Lagos, on native superstition in regard to chameleons. He thus describes an incident which he noticed in July 1912, at Onitsha, a town about 200 miles from the mouth of the Niger:—

"While walking in the long grass not far from the Mission I came across a couple of chameleons. The natives are very much afraid of that animal. It is true that when disturbed it opens its mouth wide as if to bite, but it is quite harmless. There is a curious superstition about chameleons in Nigeria. When I showed my chameleons to my boy, he rushed back shivering with terror and shouted, 'Massa, massa, this be plenty bad. If he go bite you, he bite you all time. When thunder he dey come, then he go fear, he go.'

"I could not help laughing at the stupidity of the superstition, and did my best to explain how foolish it was to believe in such nonsense. It was of no avail, the only reply was, 'he be true, all dem people dey go tell you so.'"

Anyone familiar with the mind of the West African native will know that such incidents can be paralleled wherever the chameleon occurs. I remember how when I first went to the coast I brought a chameleon home from the bush, and happening to look into the kitchen to give an order as I was passing, I was astonished to see the cook depart *via* the window, as I came in by the door.

He was an Accra man, and as far as I could make out on questioning him, his dread of the beast was based less on its supposed poisonous powers than on its possession of powers associated with the evil eye. This belief in the occult powers of the chameleon is illustrated by another incident in my experience.

I had a chameleon in captivity, and a Benin boy who acted as my gardener came to beg it of me, giving as his reason that he wanted it for the purpose of making juju, but with what particular idea I was unable to ascertain.

II. *On the Habits of African Crocodiles.*

My second note relates to the eggs of a crocodile found at the camp already mentioned.

On about April 15th, 1912, my attention was drawn by a native to croaking noises, much like the sounds made by our English frogs at the breeding-season, emanating from below the path at a spot about 6 feet from my bungalow, which is about 50 feet above water-level and about 100 yards from the lagoon.

The native told me that crocodiles' eggs must have been deposited there, and that when the young ones are about to hatch out they invariably make these sounds so that the mother may learn that they are ready and come to dig up the eggs. There were no surface indications of any disturbance of the ground, and as the path had been made of laterite crushed and rolled hard to a cement-like consistence three years before, and as there had been a daily stream of passers by on it all this time, I was not inclined to believe his story. However, on digging with a cutlass we found 13 eggs at a depth of about 18 inches. The eggs were elliptical, measuring 67 mm. in length and 42.5 mm. in maximum diameter. The croaking sounds did come from these, for some of the young crocodiles croaked as I held the eggs in my hand, and when these ceased others seemed to begin croaking in turn. The sounds were to be heard at regular intervals of five seconds.

All the eggs, except a bad one, were starred by fracture at a particular spot, at the side towards one pole, though the shell was still held in shape by the unbroken subjacent membrane, and all the young crocodiles hatched within half an hour of being dug up.

In four cases the head only came out, and as the young seemed too feeble to complete the exodus we pulled them out, after waiting a reasonable time.

The young crocodiles attempted to run off in the long grass as soon as they hatched and showed active resentment at any molestation, viciously snapping at the hand if one touched them. They were placed in a bath, in shallow water changed daily, and for about two weeks after hatching they croaked at night, especially when rain was in the air, but after that they made no sounds unless one approached after dark with a light, when an occasional croak might be heard.

They remained healthy and active, though without food, for two months, and then a small fish was administered to each, and when I came away in July they were feeding of their own accord on small fish and large freshwater shrimps.

I have been informed by natives that the young crocodiles, immediately after hatching, attach themselves to the dorsal fringe on the tail of the mother and are thus conveyed by her to the

water, but I have not been able to obtain really reliable evidence on this point.

In connection with the whole subject I find a most interesting reference in Livingstone's account of his first expedition to Africa.

In December 1853 he encamped on the banks of the river Leeba, a tributary of the Zambesi, and his statement runs as follows:—

"We saw 60 eggs taken out of a single nest. They are about the same size as those of a goose, but perfectly round. The shell is partially elastic from having a strong internal membrane and but little lime in its composition.

"The spot was about 10 feet above the water, and the broad path leading down to the river-side furnished evidence of its having been used for a similar purpose in former years. The dam after depositing her eggs covers them up, and returns to assist the young out of their place of confinement. Assistance seems necessary, for besides the tough membrane of the shell, they have four inches of earth upon them.

"They do not, however, require immediate food, because they retain a portion of the yolk equal to that of a hen's egg in a membrane in the abdomen as a stock of nutriment. When this is expended, the dam leads them to the water's edge and lets them catch fish for themselves."

It will be noticed that Dr. Livingstone described the eggs as being "perfectly round." The eggs which I saw were distinctly elliptical, and the measurements recorded were taken with callipers. I have seen still larger crocodile eggs which were also elliptical. They were 80 mm. in length and 51 mm. in diameter, and were found in a shallow nest covered with dead leaves and other débris at the foot of a large tree near the water.

Prof. Poulton has kindly furnished me with a translation by Mr. E. A. Elliott, F.Z.S., of a paper read by Dr. A. Voeltzkow in 1899 before the Berlin Academy of Sciences, "On the development and habits of *Crocodilus madagascariensis* on the East Coast."

The translation of the section dealing with points that I have mentioned runs as follows:—

"In the workroom (study) of my house I kept crocodile eggs in some boxes filled with sand, which I had always under observation, in order to observe the emergence of the young reptiles. One day I heard sounds issuing from one of these boxes, and supposed that possibly a young one had emerged and had emitted these sounds while being suffocated in the sand—which would not have surprised me, as I had long known that the young are capable of emitting sounds.

"On digging down the astonishing fact was revealed that the sounds proceeded from unbroken shells.

"The sounds were so loud that if the eggs were exposed they could be heard distinctly in the adjoining room. If, as in nature,

the eggs are covered by 1-2 metres of sand, the sounds are duller but still distinct at the length of a room. This crying of the young can be induced by walking heavily past the receptacle containing the eggs, by knocking against it, by taking an egg in the hand and turning it; in fact, any shock causes the young one to lift up its voice in the egg.

"As the female visits the nest almost daily in order to convince herself of its orderly condition, her passage from the water to the nest and back shakes the ground and induces the production of sound by those young ones which are sufficiently developed. Thereupon the old one scrapes the sand out of the pit and presently the young emerge. When eggs from my boxes were dug up and kept exposed immediately after the first sounds were heard, the young emerged in about three days.

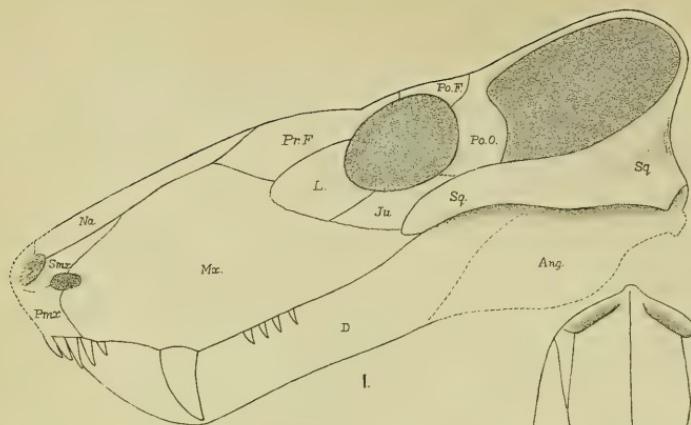
"The fact that the young give out sounds was unknown to the natives, and no one believed me until convinced by actually listening to (the sound in) the egg. I demonstrated this striking discovery to the English Consul and to the French officials at Majunga.

"The sounds are produced with the mouth closed, apparently with strong contraction of the ventral muscles sometimes, as we produce hiccup sounds, and the tone is similar."

In this paper there is also a reference to an observation by Humboldt who, in the case of *Crocodilus acutus*, notes that when incubation is complete the female returns and calls the young, which answer her voice.

Dr. Voeltzkow states that there is nothing to show whether this statement was founded on Humboldt's own observations or was simply repeated from native observation.

There is a little doubt as to the identity of the species observed by me, but Mr. G. A. Boulenger, F.R.S., in a letter to Prof. Poulton, states that he regards the common Lagos crocodile as identical with *C. niloticus*. My species is the common crocodile of the Lagos district, the largest I have seen measuring 9 feet from snout to tip of tail, and I have no doubt that it is the western form of *niloticus*; but as the habits here described do not appear to have been recorded from the West Coast and as some of the facts may be new, I have felt it desirable to put my own account on record.



Smx.

Mx.

Na.

Pr.F

Fr.

PP.

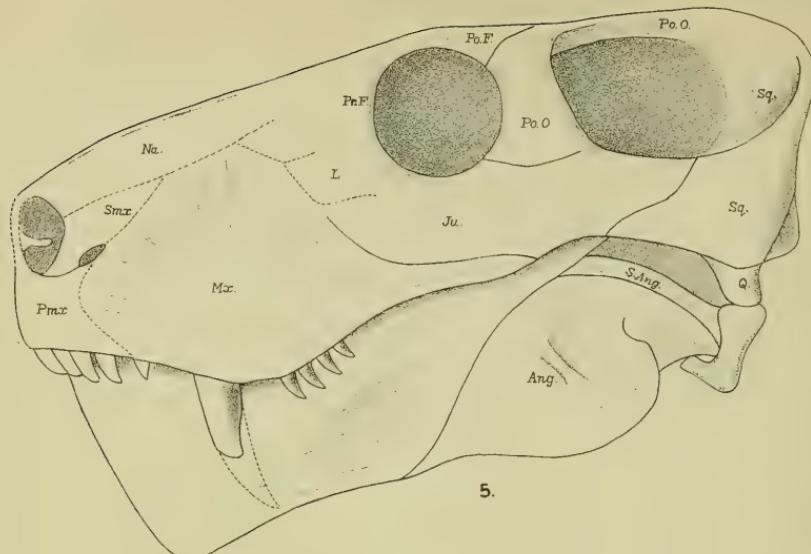
Po.F

Po.O.

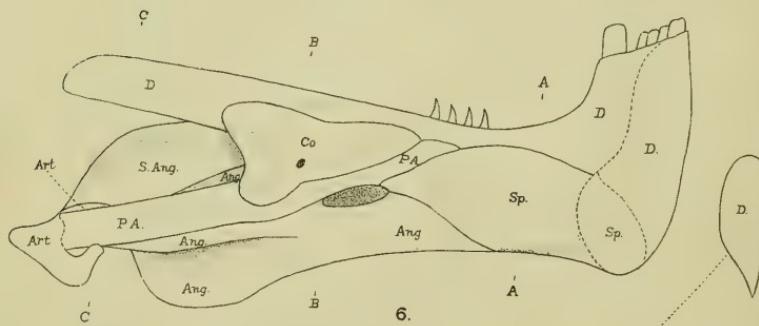
Pa.

IP.

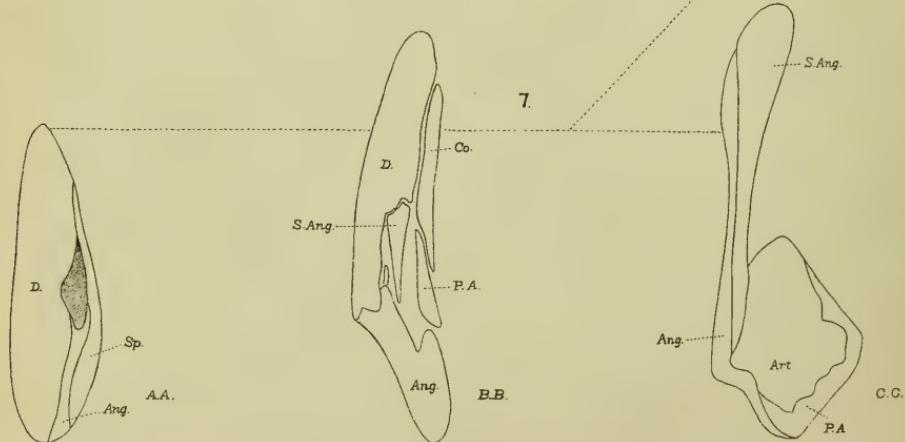
Sq.



5.



6.



Edwin Wilson, Cambridge.

R. Broom, del.
M. P. Parker, lith.

SCYMNOGNATHUS TIGRICEPS.

17. On the Gorgonopsia, a Suborder of the Mammal-like Reptiles. By R. BROOM, M.D., D.Sc., C.M.Z.S.

[Received December 31, 1912; Read February 18, 1913.]

(Plates XXXVI. & XXXVII.*)

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<i>Scymnognathus tigriceps</i>	227

When *Gorgonops torvus* was described by Owen in 1876 he regarded it as the type of a distinct group, partly on account of the apparent peculiarity of the nose, and also because the temporal region was believed to be roofed. Lydekker in 1890 and Seeley in 1895 both agreed that the temporal region was roofed, and Seeley proposed the name Gorgonopsia as a distinct order for the reception of *Gorgonops*. A re-examination of the type in 1909 convinced me that though the parietal region is wide, *Gorgonops* has temporal openings like the other Therapsida, and the discovery by the Rev. J. H. Whaits of a nearly perfect skull of *Gorgonops torvus* shows that my observation was correct.

Still one has long had the feeling that *Gorgonops* differed considerably from the typical Therocephalians. For a time I inclined to place it with *Titanosuchus* and others in the Dinocephalia. Later on I put it back among the Therocephalians. Now the discovery of one or two perfect skulls shows that the difference from the Therocephalians is sufficient to warrant the re-establishment of Seeley's group—the Gorgonopsia—as a distinct suborder of the Therapsida. I am well aware that the formation of so many new orders and suborders of reptiles as have been made in recent years has been criticized; but it seems to me wiser to separate into distinct groups forms that are manifestly distinct than to group into one order animals that are markedly different; and one can now say without any fear of contradiction that *Gorgonops* differs from the typical Therocephalians more than does a Carnivore from a Marsupial. As will be seen from the present paper, the skull in many ways approaches more nearly to that of the Anomodont.

SKULL.

Though nearly perfect skulls are known of *Gorgonops torvus* and *Scymnognathus whaitsi*, in neither species can the sutures be very clearly made out. The discovery by Mr. S. H. Haughton of two fine skulls from the *Cistecephalus* zone, and of a good skull obtained by the Rev. J. H. Whaits from the *Pareiasaurus* zone, gives us material which reveals practically every point in the structure of the skull.

* For explanation of the Plates see p. 230.

Scylacops capensis (Pl. XXXVI.).
Broom, Annals S. African Mus. 1913.

Scylacops capensis is pretty closely allied to *Gorgonops torvus*. The figures given show most of the cranial characters. The most noteworthy features seen in the figure of the side view (fig. 1) are the large septo-maxilla, the large prefrontal which meets the post-frontal and shuts out the frontal from the orbital margin, and the great forward extension of the zygomatic portion of the squamosal.

The upper view of the skull (fig. 2) shows some much more remarkable characters. The large size of the prefrontal is again seen. The frontals, though fairly large, do not reach the orbital margins. Behind the frontal is a large postfrontal bounded by the pre-frontal, the frontal, the parietal, and the postorbital. Between the back parts of the frontals and in front of the parietales is a well-developed median preparietal. Though a preparietal has long been known in most Anomodonts, it has not hitherto been detected in any other group. It is certainly absent in typical Therocephalians such as *Scylacosaurus* and *Lycosuchus*, and is apparently not present in Dinocephalians, while no trace of it exists in Cynodonts, nor has it been detected in Pelycosaurs. A careful re-examination of the skull of *Galepus jouberti* seems to show evidence of a small but distinct preparietal round the front of the large pineal foramen. We may thus regard the presence of a preparietal as a character of the Anomodontia, the Gorgonopsia, and the Dromasauria. In Anomodonts and in *Galepus* the preparietal always forms at least the anterior wall of the foramen. In the Gorgonopsia the foramen is between the parietales, and the preparietal is some distance in front. The parietales are large, and each has a process which extends far back and forms an important part of the bony wall which separates the temporal fossa from the occiput. The end of the posterior process is clasped by the squamosal. Posteriorly the parietales are mainly bounded by the large interparietal. The postorbital is very large. It forms the greater part of the post-orbital arch and the whole of the upper margin of the temporal fossa.

Whatever may be the case with the temporal fossa in the Plesiosaurs, the condition of the bones in this skull will, I think, convince everyone that the fossa in the Therapsida is the homologue of the inferior fossa of the Rhynchocephalia, as I have for a number of years maintained.

The occipital view (fig. 4) of the skull shows the great development of the squamosals and the large interparietal. The suture between the basioccipital and the exoccipitals cannot be made out, nor is there any evidence of a distinct supra-occipital. The condyle is single.

The palatal view (fig. 3) shows many features of great interest. The front part of the palate cannot be seen, and is restored from other specimens. Though the skull of *Scylacops capensis* shows

only the general appearance of the palatal elements when viewed from below, our knowledge of the morphological structure has been gained mainly by the skulls of *Scymnognathus tigriceps* and *Scylacognathus parvus*. The settling beyond question of the nature of the palate, and especially of the vomer, was a matter of such importance that I have not hesitated to break up the skulls of both of these types. As museum specimens they are none the worse for having been broken across in various directions and internally dissected, and, as a result, every detail of the internal anatomy is now known.

For many years I have known that the type of *Gorgonops torvus* showed an apparently undivided median vomer, but whether it was a true vomer or a pair of prevomers fused as we get in *Ornithorhynchus* it was impossible to tell. In typical Therocephalians there are two prevomers as in Lizards and Rhynchocephalians. In Anomodonts and Cynodonts there is a single unpaired vomer as in Mammals. A good many years ago (1895) I endeavoured to maintain that the mammalian vomer was not homologous with the reptilian paired vomers, but that these latter were the homologues of the dumb-bell bone of *Ornithorhynchus*. The question has been discussed by Gaupp, Versluys, Fuchs, Osborn, Williston, and others, but may be said to be still unsettled. As the Gorgonopsia stand between the Therocephalians on the one hand and the Anomodontia and Cynodontia on the other, it is in this suborder that we must look for a solution of the vomer problem. Unfortunately, the skulls examined still fail to give us the solution, as both *Scymnognathus* and *Scylacognathus* agree with the Anomodonts, Cynodonts, and Mammals, and differ from the Therocephalians in having a median impaired vomer and, so far as can be seen, no trace of paired vomers.

Scymnognathus tigriceps (Pl. XXXVII.).

Broom, Annals S. African Mus. 1913.

In *Scymnognathus tigriceps* the basisphenoid is very large. It has two greatly developed thick descending processes, which pass down a considerable distance below the level of the condyle. In front there is a deep but thin median keel, which passes forwards and meets the median keel formed by the united pterygoids. Above, the sphenoid passes between the pterygoids, and forms a large median plate that extends forwards and upwards as far as the plane of the front of the orbit.

The pterygoid is a huge bone which more closely resembles the pterygoid of the Pelycosaurs than that of the other South-African Therapsid suborders. The descending pterygoid process is very large, but the most remarkable feature is the enormous development of the ascending plates. These pass upwards and clasp the front of the median sphenoid. In front of the sphenoid they become ankylosed, and form a median plate which extends forward to meet the vomer. Whether this large, thin, median

plate is entirely made up of the fused pterygoids, or whether there is a median basi-cranial element as well, cannot be made out in the specimen. Certainly it is largely composed of the pterygoid plates. In *Scylacognathus* the pterygoid plates are separate from one another, and a median cartilaginous element might have been between them. Further forward the median plate in *Scymnognathus* is clasped by the ascending plates of the palatines. In front of the median plate we meet with the vomer. In *Scymnognathus* it clasps the front of the median plate, but in *Scylacognathus* it is seen clasping a median element which is not the fused pterygoids but may be regarded as ethmoid, a fact which suggests that not improbably there is in *Scymnognathus* an ethmoid element between the pterygoid plates, though no sutures can be detected. There can, I think, be no question that the vomerine bone is the true mammalian vomer. I can find no evidence of paired prevomers. The relations of the palatine bones, as viewed from underneath, can best be understood from the figure of the condition in *Scylacops* (Pl. XXXVI. fig. 3).

The mandible is beautifully preserved in *Scymnognathus*, and the condition is thus better known than in any of the Therapsidan suborders. The outer aspect, of course, and something of the internal relations of the bones, are known in all; but there are gaps in our knowledge even of the Anomodont mandible, and only of the Gorgonopsian jaw is our knowledge practically complete. Full detailed figures are thus given for later comparison with the other types (figs. 6 & 7).

The dentary is large and powerful. The front of the jaw is deep and formed by the dentary, except the base, which is splenial. About two-thirds of the outer aspect of the jaw are made up of the dentary, and there is a well-developed coronoid process. Only a little of the dentary shows on the inner aspects, as in front the inner side of the jaw is mainly splenial, and further back most of the dentary is hidden by the angular, gonial, and coronoid. The relations of these elements to the dentary will best be understood by the section and figures. The splenial extends backwards to opposite the point where the angular begins to replace the dentary on the outer side. The angular is the second largest bone in the jaw, and extends nearly the whole length. In front it is fitted in between the dentary and splenial. Posteriorly it forms the main part of the jaw. As will be seen in the drawing, there is a curious doubling of the back part, forming a deep groove for some structure. A very similar condition is seen in Pelycosaurs, though, so far as known, not in other Therapsida. There is a distinct coronoid bone, as shown in the figures, lying on the inside of the back part of the dentary. The surangular is of fair size and, with the angular, forms most of the back third of the jaw. The articular is large but short. It forms the articulation. It is clasped by the angular and the gonial. It has a peculiar posterior process which curves downwards and forwards. The gonial clasps the

inner side of the articular in front, and extends forwards between the coronoid and the angular to a little beyond the posterior end of the splenial.

POSTCRANIAL SKELETON.

The upper cervical vertebræ are very similar to those in other Therapsidans. The proatlas is large, and the upper portion of the atlas is very similar to that in Anomodonts and Dinocephalians; and the condition further resembles that of these suborders in the two halves being free and not forming a single arch as in Cynodonts.

The shoulder-girdle has a large scapula without any distinct acromion process. The coracoid and precoracoid resemble those of the Therocephalians. There is a distinct cleithrum (at least in *Scylacops*), a large clavicle and interclavicle, and an ossified sternum.

The carpus has a large radiale and ulnare and a small intermedium. There are two centralia, of which the outer is the smaller. There are four distal carpalia, but the fourth is very broad and, I believe, formed of the ankylosed fourth and fifth.

The digital formula is 2, 3, 4, 5, 3; the third toe having a small phalanx and the fourth two small phalanges as in the Therocephalia.

Very little is known of the posterior half of the body.

AFFINITIES OF THE GORGONOPSIS.

Till we know more of the structure of the Therocephalia it is impossible to say how far the Gorgonopsis differ. The differences in the skull may be tabulated as follows:—

<i>Gorgonopsis.</i>	<i>Therocephalia.</i>
1. Parietal region broad.	Parietal region narrow.
2. A preparietal bone.	No preparietal bone.
3. A large postfrontal.	Postfrontal small or absent.
4. Postorbital large, forming the upper temporal margin and meeting squamosal above.	Postorbital small, not extending far back and not meeting squamosal above.
5. A single median true vomer.	A pair of prevomers.
6. Transpalatine closely united to pterygoid.	Transpalatine separated from pterygoid by large foramen.
7. Mandibles united by powerful symphysis.	Jaws loosely articulated.
8. Angular with deep groove.	Angular perforated.

Most of the characters in which the Gorgonopsis differ from the Therocephalia are characters in which they agree with the Anomodontia. The Therocephalia are unquestionably the more primitive group, but there are some early characters in the Gorgonopsis and also in the Anomodontia. Of course we only know well one or two of the later Gorgonopsians, and we have good reason to believe that the group is very early—earlier in

South Africa perhaps than the Therocephalia, and pretty certainly earlier than the Anomodonts.

As so many of our types are founded on imperfect snouts, it will be some time, probably long, before it will be possible to divide the Gorgonopsians from the Therocephalians. All we can do at present is to give a list of the known Gorgonopsians and of those that are probably members of that group.

The known Gorgonopsians are *Gorgonops torvus* Owen, *Scymnognathus whaitsi* Broom, *Scymnognathus tigriceps* Broom & Haughton, *Scylacops capensis* Broom, and *Scylacognathus parvus* Broom.

The following are probably Gorgonopsians:—*Titanosuchus jerox* Owen, *Titanosuchus cloetei* Broom, *Scapanodon duplessisi* Broom, *Archaeosuchus cairncrossi* Broom.

Besides these there are quite a number of supposed Therocephalian genera which, on further investigation, may prove to be Gorgonopsians, such as *Inostranewia*, *Eriphostoma*, *Lycosaurus*, *Cynosuchus*, *Arctognathus*, *Ictidosaurus*, and a number of others.

Archaeosuchus occurs in beds which are Lower Permian. *Scylacognathus* and a number of other probable Gorgonopsians occur in the Middle Permian or *Pareiasaurus* zone. *Gorgonops* and *Scymnognathus whaitsi* are from the *Endothiodon* zone; while *Scymnognathus tigriceps* and *Scylacops capensis* are from the *Cistecephalus* zone or top of the Permian. From the very top of the *Cistecephalus* beds a small undescribed Gorgonopsian has just been discovered, so that we can confidently affirm that the Gorgonopsia extend throughout the Middle and Upper Permian beds, and that they probably extend from Lower Permian to Lower Trias.

EXPLANATION OF THE PLATES.

<i>Ang.</i>	Angular.	<i>Art.</i>	Articular.	<i>B.o.</i>	Basioccipital.	<i>B.s.</i>	Basisphenoid.
<i>Co.</i>	Coronoid.	<i>D.</i>	Dentare.	<i>E.o.</i>	Exoccipital.	<i>Fr.</i>	Frontal.
<i>Ju.</i>	Jugal.	<i>L.</i>	Lachrymal.	<i>Mx.</i>	Maxilla.	<i>Na.</i>	Nasal.
<i>Pa.</i>	Palatal.	<i>Pal.</i>	Palatine.	<i>Pmx.</i>	Premaxilla.	<i>Po.F.</i>	Postfrontal.
<i>Po.O.</i>	Postorbital.	<i>P.P.</i>	Preparietal.	<i>Pr.F.</i>	Prefrontal.	<i>Pt.</i>	Pterygoid.
<i>Q.</i>	Quadrata.	<i>S.Ang.</i>	Surangular.	<i>Smx.</i>	Septomaxilla.	<i>Sq.</i>	Squamosal.
<i>V.</i>	Vomer.					<i>St.</i>	Stapes.

PLATE XXXVI.

Scylacops capensis.

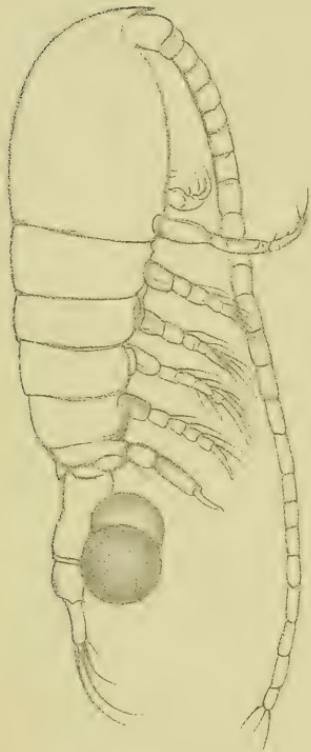
- Fig. 1. Side view of skull. About $\frac{1}{2}$ nat. size.
 2. Top view of skull. A little over $\frac{1}{2}$ nat. size.
 3. Palatal view of skull. About $\frac{1}{2}$ nat. size.
 4. Occiput. About $\frac{1}{2}$ nat. size.

PLATE XXXVII.

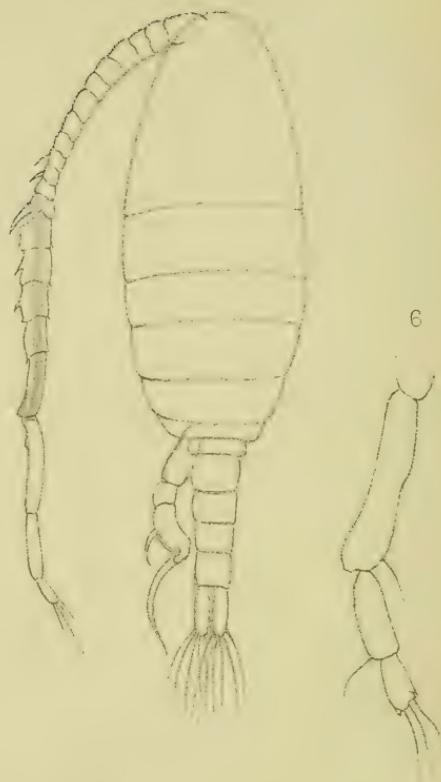
Scymnognathus tigriceps.

- Fig. 5. Side view of skull. Nearly $\frac{1}{3}$ nat. size.
 6. Inner aspect of mandible. Nearly $\frac{1}{3}$ nat. size.
 7. Sections across jaw at the places indicated in fig. 6.

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6



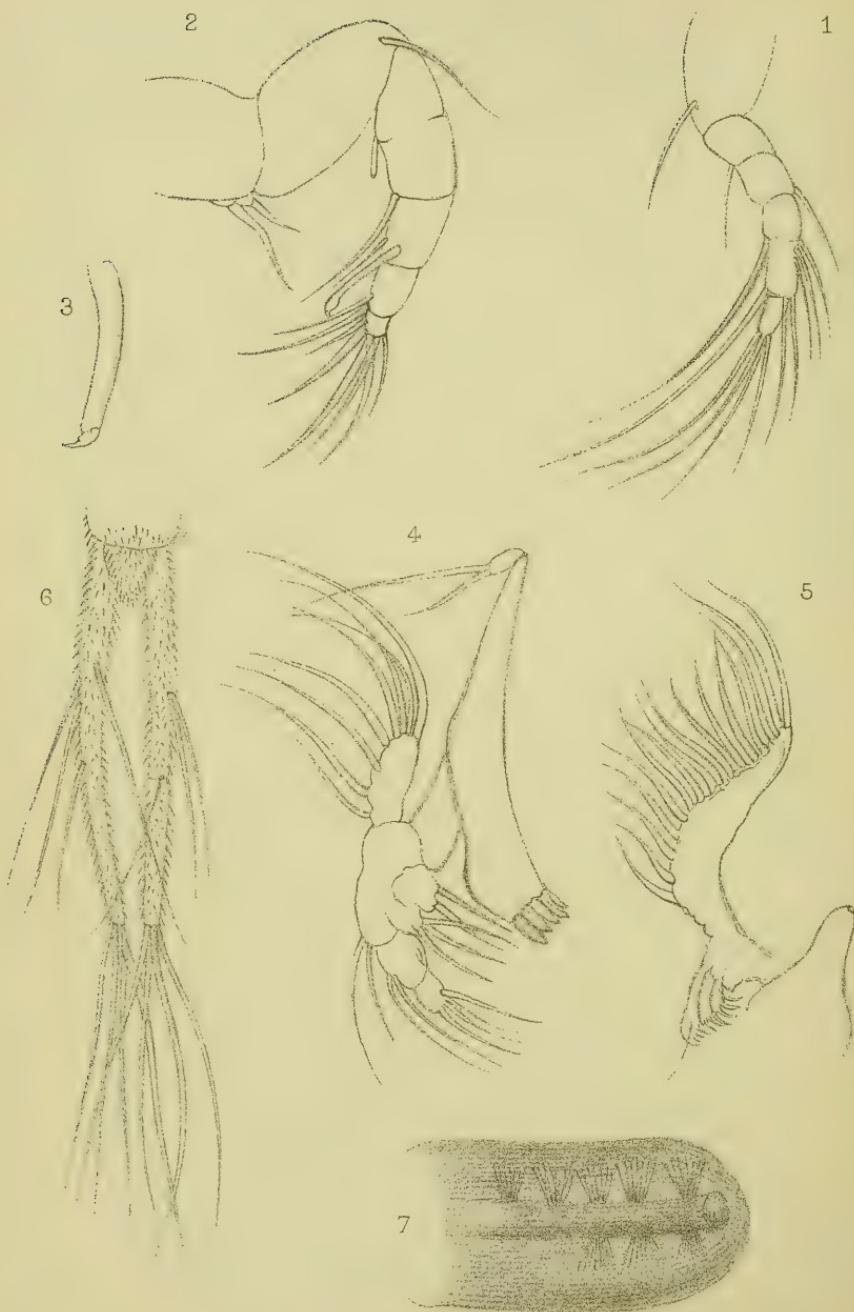
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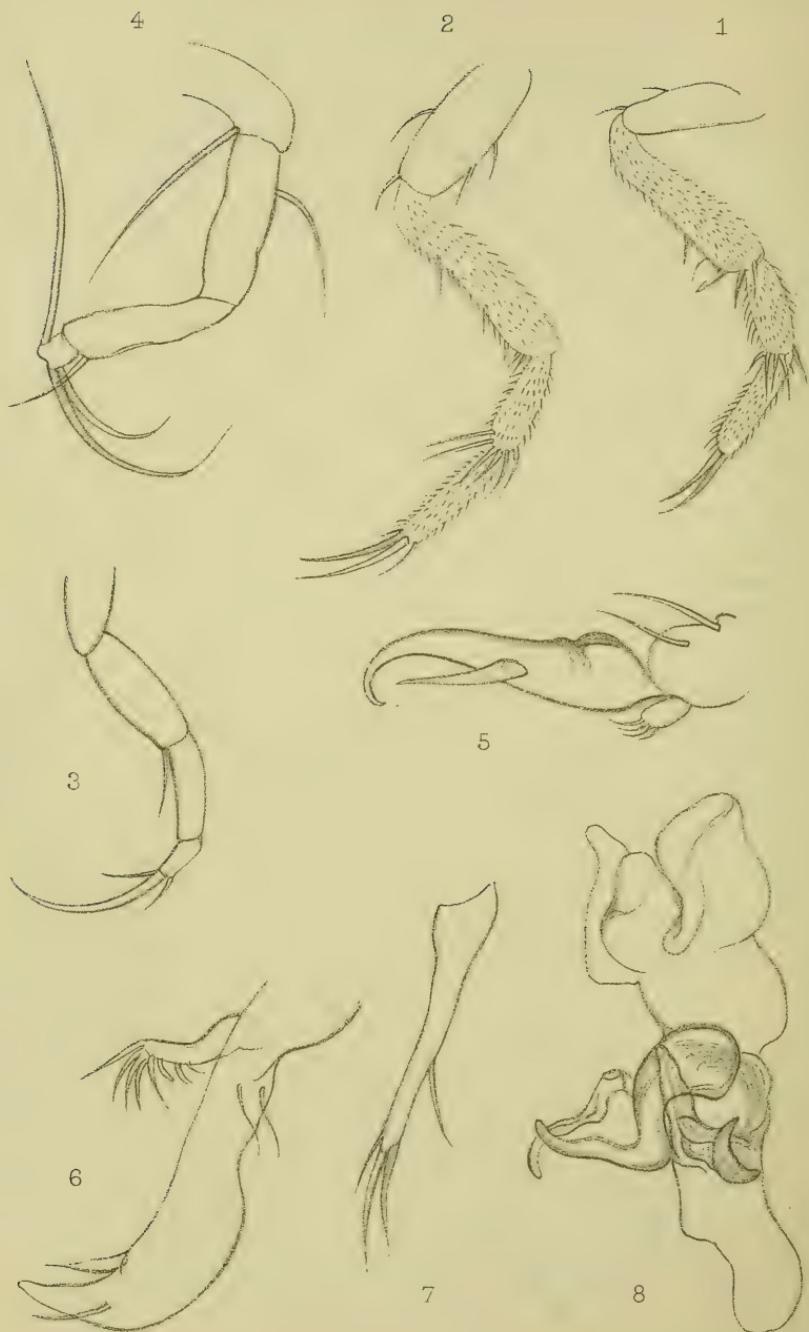


4



West, Newman lith.

ARUNELLA SUBSALSA ♂.



18. On Two British Entomostraca belonging to the Orders
Copepoda and Ostracoda. By G. STEWARDSON BRADY,
M.D., LL.D., D.Sc., F.R.S., C.M.Z.S.

[Received December 20, 1912: Read February 18, 1913.]

(Plates XXXVIII.-XL.*)

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<i>Arunella subsalsa</i> , gen. et sp. n.	232

The two species here described are the result of a recent re-examination of material collected many years ago. The first named species occurred abundantly in a gathering made by the Rev. Canon Norman, F.R.S., in Loch Ness, Scotland. The other species is, unfortunately, represented by only one specimen taken by myself near Arundel in Sussex.

Order COPEPODA.

DIAPTOMUS PUSILLUS, sp. n. (Pl. XXXVIII.)

Female.—Length 1 mm. Body slender; seen dorsally the anterior portion (cephalothorax) is quite thrice as long as broad, its anterior extremity well rounded, posterior broadly truncate with acutely mucronate lateral angles (fig. 3). Abdomen two-segmented (fig. 3), the first (genital) segment twice as long as the following segment, wide and bulbously dilated at the base, which is produced laterally and bears two aculeiform setæ; caudal rami not much longer than broad, terminal setæ very feebly plumose. Anterior antennæ slender and almost entirely destitute of marginal hairs, extending when reflexed as far as the apices of the caudal setæ (fig. 1). Basal joint of the last pair of legs (fig. 4) somewhat dilated, its outer margin prominent in the middle and bearing a short spine-like seta; inner branch short, simple, inarticulate, truncated at the apex, which bears two or three very minute setæ; outer branch about three times as long as the inner branch, its last joint forming a strong dagger-shaped claw to the dilated base of which is attached a short spine. Ovisacs very small, spherical, containing not more than one or two ova.

Male somewhat smaller than the female, length 0·98 mm. Right anterior antenna slender, very slightly dilated in the middle (fig. 2), the 13th joint bearing a single strong spine, the 10th and 11th each a very small needle-like hair, the other joints almost or entirely hairless; antepenultimate and penultimate joints simple, elongated, last joint small, bearing a few apical filaments (fig. 6). Last pair of legs strongly developed (fig. 5), the right much the larger and reaching beyond the extremities

* For explanation of the Plates see pp. 233-4.

of the caudal rami; no inner branch; distal joint ending in a long falcate claw and bearing a hook-like spine on its external margin; foot of the left side reaching scarcely as far as the two proximal joints of the right foot, imperfectly three-jointed (the basal joint being imperfectly divided), second and third joints small, tapering to a sharp point.

This interesting little species was found abundantly in a gathering made by my friend the Rev. Canon Norman, F.R.S., many years ago (1885) and kindly given to me by him. It had remained unnoticed, partly on account of its small size and partly owing to its being mixed up with numberless other Copepoda and Cladocera, until discovered on a recent re-examination of the collection. My attention was drawn to it chiefly by the very conspicuous dark coloration of the spermatophores, which were attached in unusually great numbers to the females—frequently in bunches of three or four together; the small spherical ovisacs, also very deeply pigmented, formed another mark of recognition. The gathering was from Loch Ness “off Drumnadrochit in the open lake.” In several other gatherings made by Dr. Norman during the same tour I have found no trace of this species.

Order OSTRACODA.

ARUNELLA, gen. nov.

Animal like *Candonia* except that there are three pairs of ambulatory legs in addition to the flexile fourth pair, which is contained within the shell; also a pair of setiferous appendages arising from the ventral surface of the body—probably near the base of the first pair of legs.

ARUNELLA SUBSALSA, sp. n. (Pls. XXXIX. & XL.)

Male.—Antennules six-jointed, rather sparingly setiferous (Pl. XXXIX. fig. 1); antennæ stout, six-jointed, destitute of natatory setæ, no apical claw (fig. 2), but bearing a few stout setæ, antepenultimate joint with a pair of rod-like sensory appendages (fig. 3); mandibles like those of typical *Candonæ*, mandibular palp four-jointed, with a small 7-setose branchial plate (fig. 4). First pair of maxillæ composed of a body with four digitate segments to which is attached an elongated setiferous branchial plate as in the normal Cyprididae (fig. 5); second pair strongly prehensile, each bearing a small setiferous appendage (Pl. XL. figs. 5, 6). First and second pairs of feet four-jointed, rather densely hispid with small adpressed hairs (figs. 1, 2), last joint with two strong apical claws, penultimate joint with a fascicle of about six spine-like setæ; the third pair of feet (fig. 3) destitute of hairs but armed at the extremity with a long falcate claw; fourth pair flexuous and similar to those of the normal Cyprids (fig. 4). Arising from the ventral side of the abdomen, probably near the bases of the first pair of legs, is an appendage

consisting of two slender, hispid, linear branches—unjointed, but bearing long apical and lateral setæ—with a nipple-shaped prominence separating their bases (Pl. XXXIX. fig. 6). Caudal rami slender, bearing three terminal setæ, and one near the middle of the posterior margin (Pl. XL. fig. 7); copulatory organs of the usual complex type (fig. 8); ejaculatory duct encased in a very dense and massive capsule (Pl. XXXIX. fig. 7); whorls of the duct very indistinctly visible through the fibrous covering.

Female unknown.

Of this remarkable species I have seen only one example, a male. It was found unexpectedly on a re-examination of some material collected many years ago in ditches by the side of the River Arun, near Arundel, the water being, no doubt, slightly brackish. The shell was so much encumbered with muddy débris that it could not be distinctly seen, my attention being drawn to it by the remarkably strong projection of the male organs below the margins of the valves. The animal presents characters intermediate between the Cyprididae and Cytheridae, the three pairs of ambulatory legs corresponding to those of the Cytheridae, while the following pair and the post-abdominal rami are like the similar structures in Cyprididae. But there is in addition to these limbs a remarkable biramose appendage which was detached in the process of dissection, but was probably derived from the body of the animal close to the anterior legs. This structure I take to be possibly homologous with one described by G. O. Sars * under the name "processus piliferus," and stated by that author to be found between the feet of the first pair in the male of *Bairdia subdeltoidea*. Other noteworthy characters are the presence of a pair of rodlike sensory appendages on the ante-penultimate joint of the antennæ, and the hispid clothing of the anterior legs and "processus piliferus."

I regret very much that no further specimens of *Arunella* are to be found in my collected material, but must hope that some future collector may be fortunate enough to find it, and thus be able to place the species on a more secure basis. It must evidently be hunted on the muddy bottoms of the ditches, its swimming powers being to all appearance non-existent.

EXPLANATION OF THE PLATES.

PLATE XXXVIII.

Diaptomus pusillus.

- Fig. 1. Female seen laterally, $\times 84$.
- 2. Male seen from below, $\times 84$.
- 3. Abdomen of female, with attached spermatophores, $\times 140$.
- 4. Foot of fifth pair, female, $\times 300$.
- 5. " " male, $\times 140$.
- 6. Distal joints of right anterior antenna of male, $\times 240$.

* 'Nye Bidrag til Kundskaben om Middelhavets Invertebratfauna,' p. 128, pl. xviii. fig. 12.

PLATE XXXIX.

Arunella subsalsa, ♂.

- Fig. 1. Antennule, $\times 140$.
 2. Antenna, $\times 140$.
 3. Sensory seta of antenna, $\times 300$.
 4. Mandible and palp, $\times 140$.
 5. Maxilla of first pair and labium, $\times 84$.
 6. Processus piliferus, $\times 84$.
 7. Portion of ejaculatory duct and sac, $\times 84$.

PLATE XL.

Arunella subsalsa, ♂ cont.

- Fig. 1. Foot of first pair }
 2. " second pair } $\times 84$.
 3. " third pair }
 4. " fourth pair, $\times 140$.
 5. Posterior maxilla of right side, $\times 140$.
 6. " " left side, $\times 140$.
 7. Caudal ramus, $\times 84$.
 8. Copulatory organ, $\times 84$.

19. The Dwarf Buffalo of Southern Nigeria ; with a Revision of the Dwarf Buffaloes of Western Africa *. By R. LYDEKKER, F.R.S., F.Z.S.

[Received November 14, 1912 : Read February 18, 1913.]

(Text-figures 42-44.)

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In 1910 I gave an account of certain Dwarf Buffaloes seen and shot by Lieut. H. J. L. Thompson in the Yala country of Southern Nigeria, between the Aloda towns of Echimoga and Ivezu-Okaku, in an open grassy country watered by tributaries of the Yaké†. The adult bulls were described as almost wholly black, and the cows as dun or khaki-coloured ; immature bulls being also dun. As I could not obtain specimens of these Buffaloes for the British Museum, I refrained from giving them a name. Recently, however, Lieut. A. W. Hunt, R.N., has brought home from Southern Nigeria heads of Buffaloes doubtless belonging to the same race, and as he has presented one of these, a cow, to the Museum, the time has come for naming the South Nigerian Buffalo.

* [The complete account of the two new races described in this paper appears here, but since the names and preliminary diagnoses were published in the 'Abstract,' they are distinguished by being underlined.—EDITOR.]

† See my book 'The Ox and Its Kindred,' p. 242, 1912; in line 10 from bottom, *cow* should be *bull*.

Before proceeding further, it may be remarked that the study of the Dwarf Buffaloes of Western Africa is beset with great difficulties owing to the fact that the localities of the type specimens of *Bos nanus*, *B. planiceros*, and *B. centralis* (all of which are in the Museum) are unknown.

Taking first the case of *B. planiceros*, which was named from a frontlet and horns of a very old bull, it appears that these are racially inseparable from the younger pair of horns on which *B. centralis* was based, and as there is some clue to the locality where the latter were obtained, there is a presumption that the former came from the same region. Now the type of *B. centralis* was collected by a Mr. Dalton about the year 1854, and as Mr. Thomas* has shown that at least some of Dalton's specimens came from the Gambia, there is a presumption that this may have been the case with the Buffalo-horns. This presumption is strengthened by the fact that these horns are indistinguishable from those of Buffaloes killed in Gambia by Messrs. G. Fenwick Owen and G. Russell Roberts, two specimens of which—a mounted head and a skull, with horns—were presented by the former gentleman to the Museum. This renders it practically certain that the Gambian Buffalo is identical with *B. centralis*, which appears to be inseparable from *B. planiceros*; and I accordingly apply the name *B. caffer planiceros* to the Gambian, or Sene-gambian, Buffalo, with the proviso that if the type of *planiceros* should be proved to be racially distinct from that of *centralis*—which I believe to be an impossibility—the latter name would be available for the Gambian animal. The head from the Gambia, presented by Mr. Owen to the Museum, is remarkable for the bright orange tawny colour of the throat and upper part of the chest, which, together with a patch of the same colour below each ear, contrasts strongly from the slaty black of the rest of the head. A similar bright orange tawny band characterises the whole of the under surface of a cow from Sierra Leone (adjacent to Southern Senegambia), which was living in the Zoological Gardens at Antwerp in 1875; the colour of the upper-parts being yellow—or rather, perhaps, khaki. This cow, which is described and figured by Sir Victor Brooke in the Society's 'Proceedings' for 1875, p. 455, pl. liv., I accordingly take to represent the female of *B. c. planiceros*.†

Passing on to Gray's *Bubalus brachyceros*, or *Bos caffer brachyceros*, as I prefer to call it, a difficulty has arisen with regard to the sex of the type skulls brought by Denham and Clapperton from the Lake Chad district. Hitherto I have regarded the bigger of the two as representing an adult bull and the smaller a full-grown cow, but the acquisition by the Museum of a larger series of heads of female West African Buffaloes leaves no doubt

* Ann. Mag. Nat. Hist. ser. 8, vol. viii. p. 121, 1911.

† Also figured in Brehm's 'Tierleben,' ed. 3, Säugetiere, vol. iii. p. 320, 1891; the figure being reproduced in the 'Royal Natural History,' vol. ii. p. 201. Brooke incorrectly stated that it came from Senegal.

in my mind that both are referable to full-grown cows, as was considered to be the case by Sir V. Brooke. The male of the Lake Chad race I take to be represented by a frontlet and horns (the latter in a worm-eaten condition) brought by Captain H. Cock from Northern Nigeria, some distance to the east of Kontago, or Kontagora, and presented by him to the Museum in 1904. The Dwarf Buffaloes met with during the Alexander-Gosling Expedition* from Nigeria to the Sudan in the Shari Valley and on an island in the upper Ubangui (a skull of one of which from the locality last named is in the Museum) likewise appear to be referable to this race. Two cows are described as being respectively rich and dull tawny, with black legs, black fringes to the ears, and black tail-tips; while the one bull was dull tawny with similar black points. Dwarf Buffaloes shot by Gen. P. S. Wilkinson in Northern Nigeria on the Benue River, near Abiusi, have been noticed by Mr. Pocock †. Of these an old bull was jet-black, while an apparently younger animal of the same sex is described as red, which is no doubt the equivalent of the rich tawny in the account given in Boyd Alexander's book of the male buffalo from the Ubangui, which may likewise have been comparatively young. The cows of the Benue herd appear to have been all red or bright khaki-coloured.

Here it may be mentioned that the head of a Buffalo from the interior of French Congo, described and figured by myself on page 996 of the Society's 'Proceedings' for 1910 as that of an immature male (as it was stated to be by the donor), is really that of an adult cow, as is indicated by the condition of the bases of the horns, which, like those of the type specimens of *B. c. brachyceros*, are fully formed and incapable of further growth.

From the cow of the Gambian race this head (text-fig. 42) differs by the absence of an orange tawny area on the throat and the more rufous colour of the hair, as well as by the much more upward direction and greater incurving of the horns. In the latter respect it is more like the cow, figured on page 321 of the above-mentioned volume of Brehm's 'Tierleben,' and said to be from the Congo, but differs by the much larger amount of black on the ear-fringes. The associated body-skin is wholly rufous, with the exception of a black dorsal stripe; the shanks being also dark. Unfortunately it is not known from what part of the interior of French Congo this Buffalo was obtained; but if it came from a place well to the east, there seems no reason why it should not be within the distributional area of *B. c. cottoni*, to which race it was provisionally assigned in the original description. It is possible, however, that it may belong to *B. c. nanus*.

As regards *B. c. nanus*, I take this race, which is typified by the well-known frontlet and horns in the Museum, to be also

* See Boyd Alexander, 'From the Niger to the Nile,' vol. ii. p. 394, 1907.

† 'The Field,' vol. cxix. April 5, 1912.

Text-fig. 42.



Head of Cow of *Bos caffer cottoni* (?) from the interior of French Congo.

(Reproduced from P. Z. S. 1910, text-fig. 148, p. 996.)

Text-fig. 43.



Head of Bull of *Bos caffer hunti* from Southern Nigeria.

represented by the cow and young bull from the Congo, figured on page 321 of Brehm's 'Tierleben,' ed. 3, Säugetiere, vol. iii. p. 321*, which are described as being wholly yellowish, with the exception of the brownish limbs. A full-grown bull of this race I have never seen.

The ground having thus cleared, it is now practicable to discuss Mr. Hunt's specimens, as represented by the mounted heads of an adult bull and cow. In the former of these (text-fig. 43) the general colour of the skin and hair is best described as dusky, since it is not anything like black. Compared with the aforesaid head of *B. c. planiceros* in the Museum, it shows a much smaller amount of bright orange tawny on the throat and upper part of the chest, and no upward extension of this on each side of the head towards a similar patch at the root of the ear, this patch being absent in the South Nigerian head, in which the general colour is also lighter. The fringe of long hair on the upper edge of the ear is reddish orange, but that on the opposite margin mainly dark. The horns, in addition to being considerably smaller, differ from those of the male of the Gambian Buffalo in that their front surface slopes regularly backwards almost in one plane, instead of curving at first backwards, then forwards, and finally backwards. The following are the dimensions, in inches, of the Gambian and the South Nigerian horns, together with those of the Alexander-Gosling skull from the Ubangui referred to the Lake Chad race:—

	Lake Chad.	Gambian.	S. Nigerian.
Outside length	25 $\frac{1}{4}$	27 $\frac{1}{4}$	20 $\frac{1}{2}$
Palm-breadth	6 $\frac{3}{4}$	7 $\frac{1}{2}$	7 $\frac{1}{4}$
Tip-to-tip interval	11 $\frac{1}{4}$	21 $\frac{1}{2}$	12

In the head of the South Nigerian cow (text-fig. 44) the colour is dull tawny, with a dusky tinge on the lower part of the face, but no bright orange on the throat; the fringe being bright on the upper margin of the ear, as well as in two flecks lower down, but elsewhere dark. The front surface of the horns lies wholly in one plane, instead of curving backwards as in the case of *B. c. brachyceros*. The following are the measurements of the horns in the larger of the two type specimens of the latter and of the specimen now under consideration:—

	Lake Chad.	S. Nigerian.
Outside length	17 $\frac{1}{2}$	12
Palm-breadth	4	3 $\frac{3}{4}$
Tip-to-tip interval	7	9 $\frac{1}{2}$

The foregoing measurements of the horns of the South Nigerian bull and cow agree, respectively, very fairly with those of specimens killed by Major A. J. Arnold in the Lokoja district

* The figure is reproduced in the 'Royal Natural History,' vol. ii. p. 203.

of Nigeria, at the junction of the Benue and the Niger, and quoted by myself* :—

	Bull.	Cow.
Outside length	19 $\frac{1}{2}$	12 $\frac{1}{2}$
Palm-width	7 $\frac{1}{2}$	4 $\frac{3}{4}$
Tip-to-tip interval	15	11

These Buffaloes, together with an immature mounted specimen in the Museum, from Lokoja, although hitherto referred to *B. c. nanus*, must, from their locality, be assigned, I think, to the same race as Mr. Hunt's specimens. Major Arnold states that "their colour varies from the light red of the younger animals deepening through the warm rufous red of the mature beast, to the deep dirty brown of the aged bull."†

Text-fig. 44.



Head of Cow of *Bos caffer huntii* from Southern Nigeria.

The above-mentioned female head from the French Congo agrees with the South Nigerian cow in its generally rufous colour, but differs by the more abundant and mainly black fringes to the ears, as well as by the middle portion of the front surface of the horns being distinctly curved in a backward direction.

As the result of the foregoing comparisons and descriptions, it appears that the South Nigerian Buffalo represents a relatively

* 'Game Animals of Africa,' p. 84, 1907.

† 'Game Animals of Africa,' loc. cit.

small race of *Bos caffer* in which old bulls are often dusky coloured or blackish, with a well-defined bright orange tawny area on the throat and chest, while adult cows are khaki-coloured, with an orange fringe on the upper margin of the ears, and a dusky tinge on the middle of the lower part of the face; the horns in both sexes being relatively small and lying mainly in one plane.

That these South Nigerian Buffaloes are racially distinct from *B. c. planiceros* and *B. brachyceros* seems abundantly clear; their relationship being nearer to the former than to the latter. They are also distinct from *B. c. simpsoni*, in which both sexes are blackish.

That they differ from *B. c. centralis*, as represented by the type horns and the two animals figured by Brehm, seems sufficiently apparent; and their horns are likewise different in type from those of Dr. Matschie's *B. c. thierryi* from Togoland.

On distributional grounds the South Nigerian Buffalo is unlikely to be identical with *B. c. cottoni* of the Semliki, and perhaps the interior of the French Congo; but to remove any doubt on this point it may be mentioned that in the horns of the type bull of that race (which came from Kasindi, at the north-west corner of Lake Albert Edward, and is preserved in Major Powell Cotton's Museum at Quex Park, Birchington) the outside span is $33\frac{3}{4}$ inches, against 21 in Mr. Hunt's Nigerian bull, while the palm-width in the former is 10 inches, against $7\frac{1}{4}$ in the latter. Moreover, the Semliki bull stood $57\frac{1}{4}$ inches at the shoulder, whereas an adult Nigerian bull shot by Major Arnold measured only 44 inches. *B. c. cottoni* cannot therefore be termed a Dwarf Buffalo.

As the South Nigerian Buffalo cannot apparently be identified with any of the named races, I propose to call it *Bos (Bubalus) caffer huntii* [P. Z. S. Abstract, 1912, p. 6 (February 25th)], taking the head of the cow presented to the Museum (text-fig. 44) as the type.

The occurrence of this race of Buffaloes in Southern Nigeria renders it practically certain that an adult bull Buffalo from Ashanti presented to the Museum by Mr. C. Beddington in 1900, and hitherto identified with *B. c. nanus*, cannot belong to a race inhabiting the Congo. Since, moreover, the fringe of hair on the ears is much less abundant, and the horns are considerably less closely approximated at the tips than in the type of *nanus*, I propose to make this bull the type of a new race, under the name *Bos (Bubalus) caffer beddingtoni* [P. Z. S. Abstract, 1912, p. 6 (February 25th)]. The height at the shoulder is $51\frac{1}{2}$ inches, the outside length of the horns $20\frac{1}{2}$, the palm-width $6\frac{1}{4}$, the tip-to-tip interval $13\frac{1}{2}$, and the outside span $23\frac{3}{4}$ inches. There is no dark dorsal stripe, which apparently occurs in *nanus*.

In conclusion I give the following tentative "key" to the named races of West African Dwarf Buffaloes in which the colour of the coat is known:—

- A. Both sexes dark; horns regularly curved in a subcircular form.
 Size medium *B. c. simpsoni.*
- B. Adult bulls often dark, young bulls and cows red or tawny; horns more expanded laterally.
- a. Throat of bulls orange tawny.
 a'. Size large; throat of cows orange *B. c. planiceros.*
 a''. Size smaller; throat of cows coloured like neck; horns mainly in one plane; ear-fringe of cows partly orange *B. c. hunti.*
- b. Apparently no orange on throat.
 Size medium; horns strongly bent backwards; ear-fringe of cows mainly black *B. c. brachyceros.*
- C. Adults of both sexes rufous or tawny; horns more or less angulated and flattened.
- a. Size small; horns strongly angulated; heavy ear-fringes; apparently a dark dorsal stripe *B. c. nanus.*
 b. Size apparently larger; horns less strongly angulated; less abundant ear-fringes; no dark dorsal stripe *B. c. beddingtoni.*

[Since the above was written I have seen specimens which show that old bulls of *B. c. hunti* may retain the red coat while younger ones may be dusky.]

EXHIBITIONS AND NOTICES.

March 4, 1913.

Dr. A. SMITH WOODWARD, F.R.S., Vice-President,
 in the Chair.

Dr. P. CHALMERS MITCHELL, F.R.S., F.Z.S., Secretary of the Society, exhibited a lantern-slide made from a photograph of a domestic Donkey (*Equus asinus*) taken by Captain C. H. Armitage in the Gold Coast, and showing a very remarkable pattern of transversely arranged black stripes on the flank.

Mr. E. G. BOULENGER, F.Z.S., Curator of Reptiles, made remarks on the Lung-Fish, *Propterus aethiopicus*, which the Society had recently received from Mr. C. W. Woodhouse, and which was the only Dipnoan that had not previously been exhibited alive in Europe.

Dr. S. F. HARMER, M.A., F.R.S., exhibited a Hair-ball which was presented to the British Museum (Natural History) by Mr. A. Dobrée, in January 1911. Alluding to Mr. E. G. Boulenger's exhibit, on February 18th last, of spines of a Madagascar Insectivore in the excrement of a Boa, he pointed out that this was perhaps another case of the occurrence of spiny hairs in the alimentary canal of a reptile. Mr. Dobrée's specimen, which has been described by Mr. R. Lydekker, F.R.S., in 'The Field,' vol. 117, Feb. 25, 1911, p. 383, was found in the Province of Morondava, West Coast of Madagascar, between Belô on the

Tsiribihina River and Bevilô; and it has the form of a hair-ball, consisting largely of the hairs of Tenrecs (*Centetes*). Bearing Mr. Boulenger's remarks in mind, it is possible that the specimen in question may have come from a Boa; but it seems to be more probable that it came from the stomach of a Crocodile. The principal reason for coming to this conclusion is the evidence supplied by Mr. J. Simão da Costa to the British Museum that hair-balls of this nature occur in the stomachs of Crocodilians in N. Brazil, as recorded by Mr. Lydekker in the note above referred to.

March 18, 1913.

E. G. B. MEADE-WALDO, Esq., Vice-President,
in the Chair.

The SECRETARY read the following report on the additions that had been made to the Society's Menagerie during the month of February, 1913:—

The registered additions to the Society's Menagerie during the month of February were 151 in number. Of these, 59 were acquired by presentation, 27 by purchase, 45 were received on deposit, 2 in exchange, and 18 were born in the Gardens.

The number of departures during the same period, by deaths and removals, was 153.

Amongst the additions special attention may be directed to:—

1 Fishing Cat (*Felis viverrina*) ♂, from Meerpore, presented by J. S. E. Walker, Esq., on February 15th.

1 Pigmy Hippopotamus (*Chœropsis liberiensis*) ♀, from Liberia, new to the Collection, purchased on February 6th.

1 Isabella Gazelle (*Gazella isabella*) ♀, from Suakin, and 1 Persian Gazelle (*Gazella subgutturosa*) ♂, from Persia, presented by Oswald Darke, Esq., on February 14th.

1 Mikado Pheasant (*Calophasis mikado*), from Mount Arizan, Formosa, new to the Collection, deposited on February 25th.

2 White-eyebrowed Finches (*Sporophila superciliaris*), from Brazil, new to the Collection, purchased on February 5th.

1 Guatemalan Ouzel (*Merula infuscata*), 2 Cinnamon Tinamous (*Crypturus cinnamomeus*), from South America, 3 Lesser Scaup (*Fuligula affinis*), 1 Ringed Duck (*Fuligula collaris*), from North America, new to the Collection, deposited on February 25th.

1 Eyed Gecko (*Œdura ocellata*), from Australia, new to the Collection, presented by C. R. Walter, Esq., F.Z.S., on February 8th.

1 Helen's Snake (*Coluber helena*), from Ceylon, new to the Collection, purchased on February 10th.

6 Argentine Dwarf Toads (*Phrynniscus nigricans*), from Monte Video, new to the Collection, presented by W. Parkinson Curtis, Esq., on February 11th.

2 Diamond-Bass (*Enneacanthus gloriosus*), from N. America, new to the Collection, deposited on February 25th.

PAPERS.

20. Contributions to the Anatomy and Systematic Arrangement of the Cestoidea. By FRANK E. BEDDARD, M.A., D.Sc., F.R.S., F.Z.S., Prosector to the Society.

[Received January 14, 1913 : Read March 4, 1913.]

IX. ON A NEW GENUS OF ICHTHYOTÆNIIDS.

(Text-figures 45-53.)

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A considerable number of examples of a rather large species of tapeworms clearly referable to the family Ichthyotæniidae was obtained in 1911 from the Crossed Viper (*Lachesis alternans*). It is only recently that I have subjected these specimens to a careful examination, and they prove to represent a species which is most nearly akin to my recently constituted genus *Ophidotenia**, but present characters which seem to me to justify their inclusion within a new genus, which I term, by reason of a salient external character of the ripe proglottids, *Solenotænia*. This character is obvious in fully mature proglottids (see text-fig. 49, p. 250) as a well-marked ventral groove extending along nearly the whole of the proglottid on the ventral surface. It is generally quite visible to the naked eye, when it appears to vary in length in different proglottids, being in fact a mark of maturity.

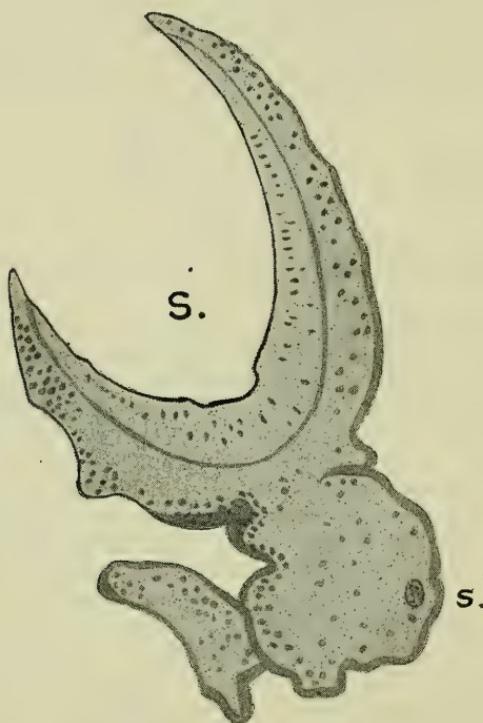
The general aspect of this tapeworm is that of other Ichthyotæniids, and it is quite like *Ichthyotænia gabonica*, which I have recently described, so far as external characters go, with the exception, of course, of the ventral groove, to which I have just referred. The length is at least 5 or 6 inches, and the breadth of the ripe proglottids rather more than 2 mm. The body does not narrow much at the head end, and the scolex is more than 1 mm. wide. There is a neck which is at first narrower than the scolex. In transverse sections the scolex showed no peculiarities that I could detect. There was hardly any rostellar region, the suckers being very large.

In addition to the four large suckers (which are of course unarmed, like those of other Ichthyotæniids), there is a very small apical structure of a somewhat different nature. It is less cup-shaped and more funnel-shaped than the lateral suckers, narrowing rapidly at its internal end. At the same time the

* See P. Z. S. 1913, p. 25.

minute structure of this apical organ seems to indicate that it is to be regarded rather as a sucker than a rostellum. The apical organ of *Acanthotænia**, on the other hand, is, as I think, of the nature of the rostellum of other tapeworms.

Text-fig. 45.

Transverse section through scolex of *Solenotænia viperis*.

S. One of four large suckers. s. Small apical sucker showing its minute size in comparison with large suckers.

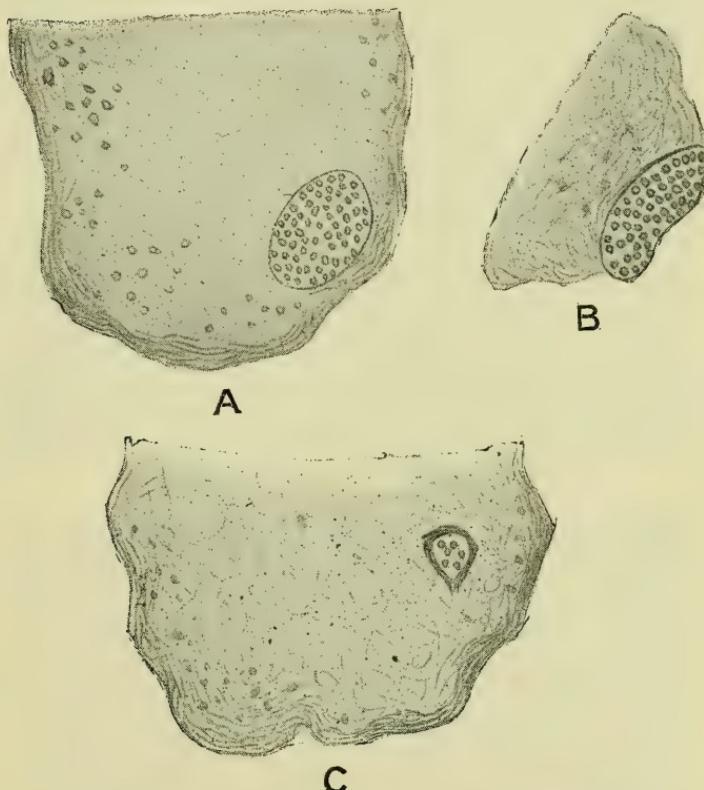
The accompanying figure (text-fig. 46) shows several out of a series of transverse, slightly oblique, sections through this apical sucker. Being rather oblique they show the external surface, which is slightly concave. The nuclei, which are chiefly towards the external surface of the sucker, seem to me to be rather larger than those in the four lateral suckers. Previous investigations upon this apical structure are not entirely conclusive. Rigganbach † finds an apical depression in *Ichthyotænia*

* P. Z. S. 1913, p. 8, text-fig. 1, R.

† "Das Genus *Ichthyotænia*," Rev. Suisse Zool. iv. 1897, p. 165.

fossata, which his figures * show to be, relatively to the lateral suckers, very much smaller than in *Solenotænia viperis*. But he is not able to be decisive as to its minute structure or nature—that is, whether sucker or rostellum. He quotes the opinion of Monticelli † that the organ in question is a sucker, and points out that Lühe ‡ seems to regard it as a rudimentary rostellum.

Text-fig. 46.



Three nearly consecutive sections through minute apical sucker of
Solenotænia viperis.

- A. At a little distance from the surface. B. At the actual apex of the scolex.
- C. Near to deep end of apical sucker.

This structure is figured in *Ichthyotænia ocellata* by Kraemer in a memoir upon Tænias from fish §, who regards it as a sucker.

* Loc. cit. pl. vii. figs. 1, 3, 4.

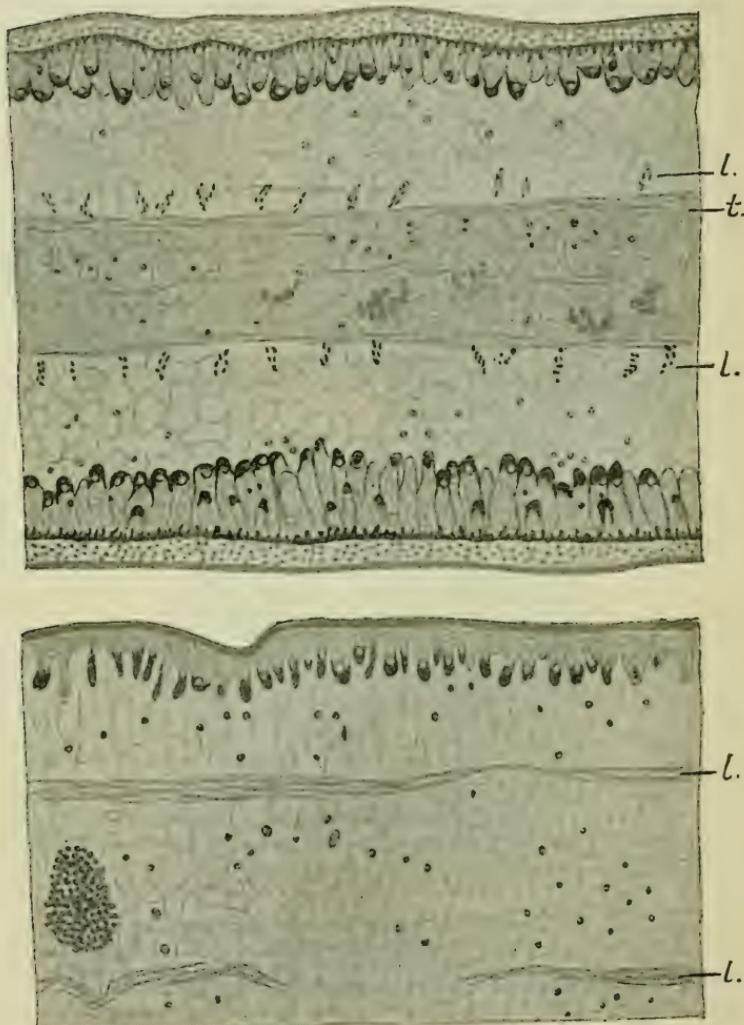
† Boll. Soc. Nat. Napoli (1) v., 1891.

‡ Zool. Anz. 1894.

§ Zeitschr. wiss. Zool. liii. 1892, pl. xxviii. fig. 40.

In tabulating the characteristics of the fish *Tænias*, Kraemer writes thus: * "Der Mangel eines Rostellums, anstatt dessen

Text-fig. 47.



Upper figure a transverse section through part of a proglottid of *Solenotænia viperis*; lower figure a longitudinal section through part of a proglottid.

l. Longitudinal muscles. *t.* Transverse muscles.

* Zeitschr. wiss. Zool., loc. cit. p. 718.

häufig ein den Scheitel des Scolex einnehmender, kleiner fünfter Saugnapf entwickelt ist. Das Vorhandensein eines scheitälständigen Saugnapfes ist wohl ein ursprüngliches, den niederen Formen der Tänien eigenes Verhalten." The balance of opinion, therefore, seems in favour of regarding an apical organ as characteristic of the Ichthyotæniidæ, but to leave it for the present doubtful whether we are to describe this organ as a sucker or as a rudimentary rostellum. It appears to me that there is evidence in favour of believing that both structures are present among the members of the family Ichthyotæniidæ, and that *Acanthotænia* is to be characterised by the possession of a rostellum while *Solenotænia* has an apical sucker. But it may be that both structures have a common origin.

In transverse sections of the neck region muscular fibres, forming a longitudinal layer, are visible. But these fibres do not form a compact layer; they are scattered singly through the parenchyma, and not massed into bundles, as in *Acanthotænia*, or into a definite layer, as in some other Ichthyotæniids. Further back the fibres of the longitudinal layer are arranged in bundles; these bundles are small, consisting of but few fibres and with considerable interspaces, where there are no longitudinal fibres delimiting the cortical from the medullary layer. The position of the bundles, and therefore the length of the interspaces, are not regular, and the fibres of each bundle (in which I have counted about 4-7) are apt to be placed one on top of the other, thus forming a line at right angles to the long axis of the transverse section. Longitudinal sections through the proglottids illustrate also the scattered condition of the small bundles of longitudinal fibres; for there are to be seen frequent gaps where the cortical layer is not separated from the medullary layer by these fibres. There are apparently, as will be seen in text-fig. 47, transverse muscular fibres in the medullary layer.

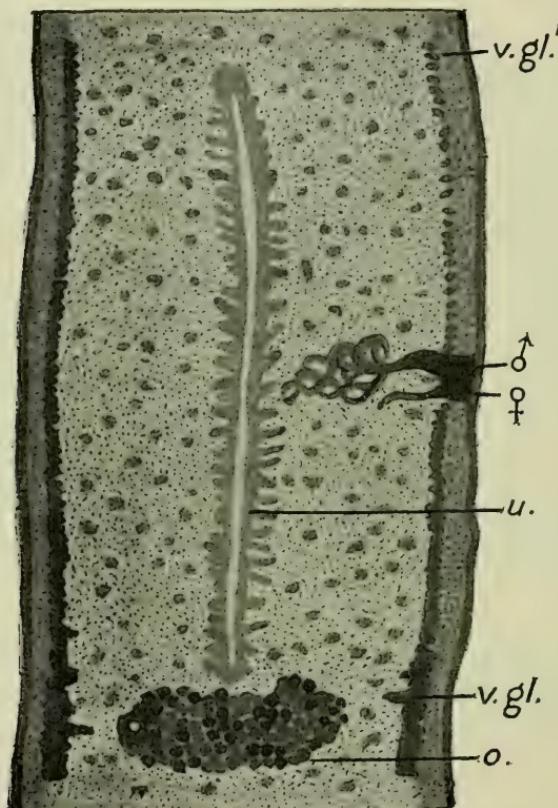
The generative system of *Solenotænia* is like that of other Ichthyotæniids, with certain peculiarities of its own and features that it shares only with *Ophidotænia*. The accompanying text-figure (text-fig. 48) is a view of a mature proglottid mounted entire, and it shows the general arrangement of the various parts of the generative system. The marginal generative pores lie quite at the middle point of the segment, and the cirrus is seen to be occasionally protruded. As in other Ichthyotæniids, the male pore is sometimes in front of and sometimes behind the vaginal pore.

The vitelline glands are very plain in such preparations, and form the usual strips extending through the greater part of the length of the proglottid. Marotel * has represented the vitelline glands of *Ichthyotænia calmettei* as consisting of numerous and separate follicles. I find in the present species in certain regions an obvious separation between the adjacent follicles; elsewhere,

* Arch. de Parasitol. 1899, p. 34.

on the other hand, the individual glands are connected into a more continuous mass. This is shown in the accompanying figure (text-fig. 48).

Text-fig. 48.



View of an entire proglottid of *Solenotænia viperis* stained and mounted as a transparent object.

♂, opening of cirrus-sac; ♀, opening of vagina.

o. Ovary. *u.* Uterus showing open groove on surface of body and irregularly paired diverticula. *v.g.* posterior region of vitelline gland, which is of greater diameter than the anterior region and which gives off one or two processes towards the middle line of the body. *v.g.'* Anterior thinner region of the vitelline gland.

The same text-figure also shows a peculiarity which is apparently, at least, not universal among these tapeworms. Towards the posterior end of the proglottid the marginal strip of vitelline gland gives off one or two processes of vitelline tissue which pass to the interior of the proglottid in the direction of the

ovary. These ingrowths of the vitelline tissue are limited to the posterior region of the gland. Furthermore, the preparation which is represented in the text-figure shows that the vitelline gland is distinctly thicker posteriorly in the region of the ovary, and that it tapers somewhat anteriorly. These apparently minute facts are important when we consider the characteristics of the vitelline glands among the Cestoidea. Among the Tetracotylea (=Cyclophyllidea), to which group *Ichthyotænia* and its immediate allies have been by some referred, the vitelline gland is single and compact, and lies nearly always behind the ovary, i.e. quite posterior in the segment, but always near to the ovary. On the other hand, the Tetraphyllidea, to which *Ichthyotænia* and its allies are more generally referred, have strip-like vitelline glands situated laterally.

At first sight Ichthyotæniids appear to conform entirely with the latter definition. It seems to me, however, that *Solenotænia* shows quite intermediate characters. The thinning of the vitelline strip anteriorly, and the projections posteriorly directed towards the middle line of the proglottid, if they were carried farther—i.e. to the disappearance of the anterior part of the glands and the junction of the posterior regions—would produce the vitelline gland characteristic of the Tetracotylea. Another matter in reference to the vitelline glands remains for consideration. Rigggenbach *, in his account of the anatomy of *Ichthyotænia absisa*, distinctly states that the vitelline strips lie outside of the water-tubes and the nerve-cord, while Schwarz † writes absolutely to the same effect of *I. nattereri*: “Die Dotterstücke liegen wie bei allen Ichthyotæniens ganz randständig, ausserhalb der Nerven und der Längsgefässe und reichen vom vordern Gliedrande bis zum hintern.” This obviously implies their position in the cortical parenchyma.

In defining the Tetraphyllidea, in which group he includes the Ichthyotæniidae as a family, Prof. Max Braun ‡ writes: “Dotterstücke in zwei seitlichen Feldern resp. in randständigen Längstreifen—in der Rindenschicht.” This phrase seems to imply an agreement with the opinions just quoted, i.e., that the strips of vitelline follicles lie in the cortical layer outside the nerve-cord. Nevertheless in a figure § (copied from Kraemer) it is distinctly shown that in “*Tenia filicollis*” (an *Ichthyotænia*) the vitelline strips lie within, not only the nerve-cord, but the water-vessel. In *Solenotænia* there is no doubt that the vitelline strips lie to the inside of the nerve-cord though outside of the water-vascular tube, and are thus obviously medullary in position. They also certainly lie within the nerve-cord in other Ichthyotæniids which I have myself || had the opportunity of examining.

* Rev. Suisse Zool. iv. 1897, p. 210.

† “Die Ichthyotæniiden der Reptilien,” Inaug.-Diss. Univ. Basel, 1908, p. 22.

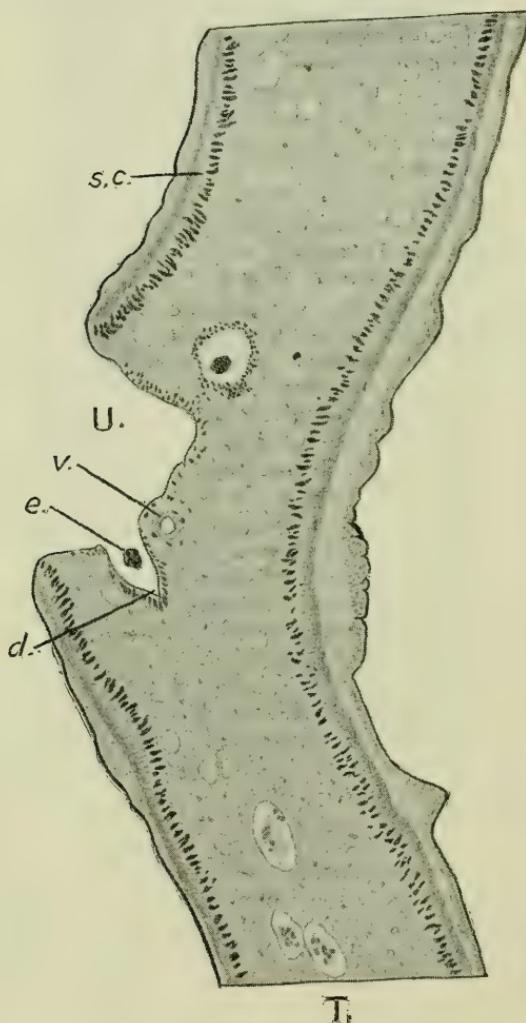
‡ Bronn’s ‘Thierreichs,’ Bd. iv. Abth. 1 B, p. 1699.

§ Loc. cit. Taf. Iv. fig. 5.

|| P. Z. S. 1913, p. 4.

The groove upon the ventral surface of the mature proglottids, referred to above, cannot, as I think, be compared with the ventral and dorsal grooves upon the proglottids of *Ptychobothrium*

Text-fig. 49.



Transverse section through middle region of proglottid of *Solenotænia viperis*, to show the ventral uterine groove.

d. Diverticulum of uterus containing an embryo (*e*). The opening into the uterus of the corresponding diverticulum is not shown on the opposite side. *sc.* Subcuticular layer. *T.* Testis. *U.* Uterus. *v.* Vagina.

belones *. For in that Bothriocephalid the uterine pore or genital pore opens into one or other of the grooves. In *Solenotænia*, on the other hand, the groove is actually the interior of the median stem of the uterus, which is exposed to the exterior by a splitting of the integument. The origin of this state of affairs is a question to which I shall recur later. The extent and depth of the groove is indicated in text-fig. 48, when seen from below in a proglottid mounted entire, and in text-fig. 49 in transverse section. On the superficial view the actual groove is seen to occupy as nearly as possible the median ventral line of the proglottid, and to be not broader than 1/7th to 1/10th of the diameter of the proglottid. The variation in breadth is of course due to the amount of gape of the slit, which may be quite coextensive with the breadth of the median stem of the uterus.

In transverse sections (see text-fig. 49) the gape of the ventral groove is often seen to be fully as wide as the lumen of the uterus. The diverticula open into this canal on either side. On the whole they form two more or less regular rows, one on each side (right and left) of the median groove. I have, however, seen them more crowded, two diverticula opening close together on one side and one on the other. There is thus no perfect regularity, as is indeed generally the case with the uterine diverticula in the Ichthyotæniids.

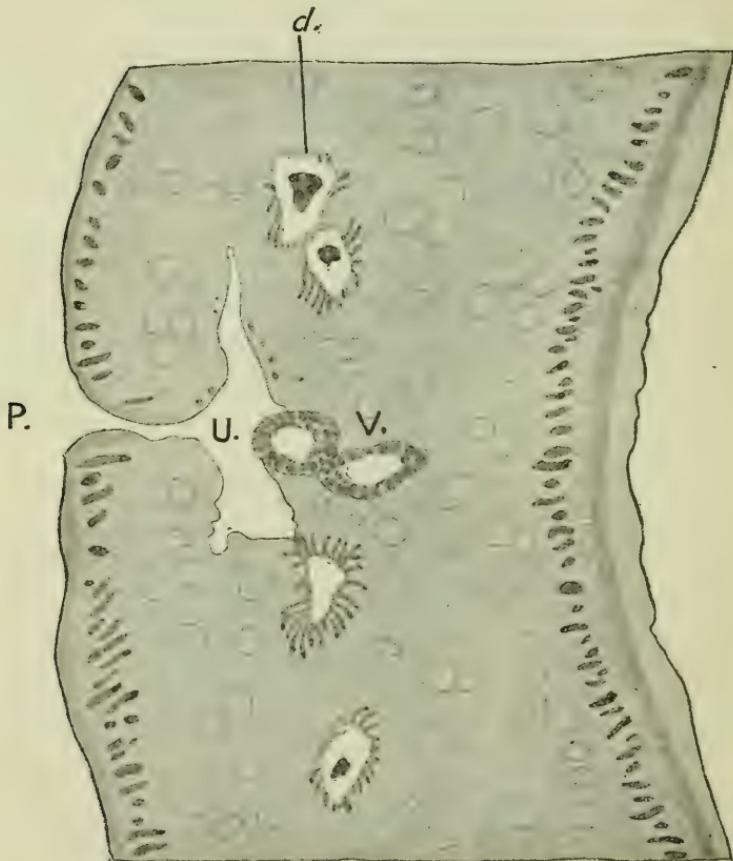
It is very noteworthy that the continuous slit later nowhere shows signs of tearing or bursting; its edges are smooth and regular. This, of course, might be explained by the pre-existence in earlier stages of the development of the uterus of a series of uterine pores, increasing slightly in longitudinal diameter, and thus leading eventually to a smooth and easy tear, such as is effected in sheets of postage stamps. To this matter I shall again draw attention in considering immature stages of the uterus. I have examined carefully the end of the ventral groove, close to the ovary, where the uterus of course commences.

The conditions met with at this end of the uterus are very suggestive of a pre-existing pore. There is, in fact, as shown in the accompanying drawing (text-fig. 50, p. 252), a distinct and funnel-like in-pushing of the subcuticular layer of cells (and overlying cuticle), which opens into the cavity of the median stem of the uterus. The subcuticular cells in the funnel-like in-pushing come to lie at right angles, or nearly so, to the subcuticular cells upon the general surface of the body. The narrow aperture of communication thus formed, widens out in subsequent sections to the wide gape already described. It must be admitted that this funnel-like involution (as it apparently is) is not altogether like the uterine pores which I have recently described and figured

* Lönnberg, "Anatomische Studien über skandinavische Cestoden," K. Svensk. Vet.-Ak. Handl. Bd. xxiv. (1891) No. 6; for a figure, see Bronn's Thierreichs, Bd. iv. Abth. 1B, Taf. xlvi. fig. 4.

in *Ophidotaenia**, where there is not a very marked funnel-shaped ingrowth of the subcuticular layer to meet the cellular tube which grows out from the uterus. It will be noted, however, that there

Text-fig. 50.



Transverse section through middle of a proglottid of *Solenotænia viperis* at posterior end of uterine groove.

- d. Diverticula of uterus containing embryos. P. External pore which forms the commencement of the ventral uterine groove. U. Uterus. V. Vagina, which is seen cut through twice, being coiled in this region near to the ovary.

is some comparison possible between the conditions that I have just described and those asserted to exist by Zschokke in certain allied genera of Cestodes.

* P. Z. S. 1913, p. 30, text-fig. 9.

A salient character of the uterus of this genus *Solenotænia* is afforded by the diverticula. This character is shared by *Ophidotænia*, and the diverticula appear to me to be quite similar in both of these genera of Ichthyotæniidae. The peculiarity of these diverticula is, first of all, their clear separation from the uterine stem into which they open, often by a very narrow mouth, and, secondly, the delicate long-stalked glandular cells which beset them externally (text-fig. 51). As I have already pointed out in the case of *Ophidotænia*, these cells seem to be exactly like those of the shell-gland in other tapeworms, and I can here say the same of those of *Solenotænia*. It appeared to me to be right in the case of the allied form *Ophidotænia naiae** to correlate the

Text-fig. 51.



A transverse section of one of the uterine diverticula of *Solenotænia viperis* highly magnified to show the long-stalked glandular cells which form the greater part of its walls.

presence of these cells, distinguishing the diverticula of the uterus of this genus from those of *Ichthyotænia*, with the absence of a well-marked shell-gland, which is very conspicuous in many species of *Ichthyotænia*. I find, however, in *Solenotænia viperis* a short thick-walled region of the oviducal apparatus, which I take to be the equivalent of the shell-gland. This is far less conspicuous than the shell-gland of *Ichthyotænia*, where I have seen it; and the cells are not stalked, and have thus not the characteristic appearance so well known in Cestodes.

In less fully mature proglottids, where there is no ventral groove upon the ventral face of the body, the uterus is a simple

* P. Z. S. 1913, p. 33.

tube of approximately circular contour in transverse section. At its termination its walls are quite thin, and consist of little but a membrane. But elsewhere, although there are no diverticula as in the ripe uterus, the walls are laterally marked by a thick layer of cells (text-fig. 52), which are the forerunners of the pear-shaped cells which deck the diverticula of the mature uterus; so, at least, I presume. These cells form a heap on each side, and are not markedly pear-shaped. Rather, indeed, are they circular in outline. In many sections this uterine tube is seen to lie at some distance from the ventral body-wall, and a certain thickness of cortical parenchyma lies between it and the glandular subcuticular layer. In other regions of the proglottid and for a considerable number of consecutive sections, the shape of the uterus in transverse section becomes pear-shaped, the tube thus extending right up to the subcuticular layer, which is, however, as far as I could ascertain, not perforated anywhere.

The cavity of the uterus is here not large, and it is not swollen with eggs, of which, indeed, but few are to be observed at this stage in its cavity, and those not mature*.

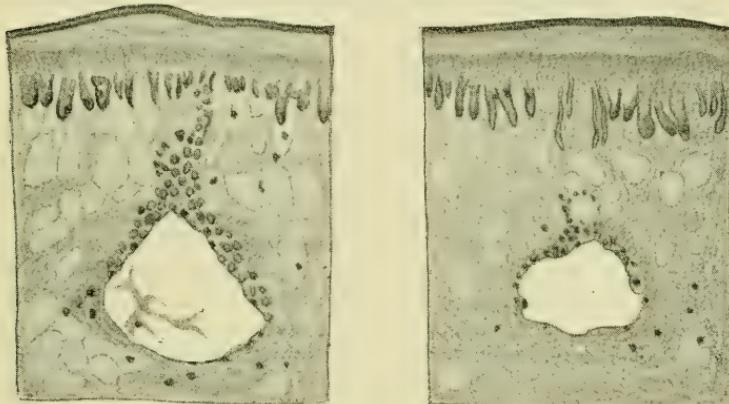
I have recently described in *Ichthyotænia gabonica*† prolongations of the uterus towards the exterior, the histological details of which offer reasons for believing that they are rudimentary (perhaps incipient) external uterine pores like those so plain in *Ophidotænia*. In the former species, however, there was not always so marked an extension of the cavity of the uterus as of the tissues forming its walls. In *Solenotænia*, on the other hand, what is generally met with is rather an extension of the uterine cavity which often came to underlie considerably the subcuticular layer. A weak line is thus formed, which by splitting forms the ventral groove so characteristic of the mature proglottids of this Ichthyotæniid. Occasionally, however, the approach of the prolongation of the uterus to the cuticle is associated with the disappearance of the subcuticular layer for a brief space. Such spots seem to me to represent the uterine pores of *Ophidotænia*. The existence of the remains of an external pore is, I think, well shown in text-fig. 52. This illustrates two out of about six sections through the uterus of a not fully mature proglottid close to it, beginning at the ovarian end of the proglottid. The uterus consists in each of these few sections of a circular area suspended by a thin stalk from the subcuticular layer. The stalk is not hollow but composed of a nucleated layer of cells, continuous with the walls of the uterus, and very distinctly not formed as a specialised tract of the medullary parenchyma. In one of the two sections selected for figuring here it appears to me that this duct, as I regard it, could be followed as far as to the cuticle. I could not, however, see

* I am, indeed, not quite certain that they are eggs.

† P. Z. S. 1913, p. 157, text-fig. 34.

anywhere a lumen in this cord of cells. That fact, nevertheless, can hardly be regarded as militating against the view that I take of their nature. Following this series of sections to which I have just referred onwards the cord of cells ceases absolutely, and the uterus is to be seen as a circular cavity lying some way away from the subcuticular layer. Very soon, however, it grows out towards the cuticle with a lumen throughout which reaches the subcuticular layer. There is no obvious suggestion here of a duct. In fact, the condition of the ripe uterus in *Solenotænia* is not altogether easy of comparison in detail with that of *Ophidotoenia*.

Text-fig. 52.



Two nearly consecutive sections through unripe uterus of *Solenotænia viperis* showing (in the left-hand figure) a rudimentary external pore. The lateral thickenings of the uterine tube are probably the commencement of the lateral diverticula.

The above facts in the structure of the uterus of *Solenotænia* show clearly that it is to be referred to the same type as that which characterises the genus *Ophidotoenia*, differing therefore from that of *Ichthyotænia sensu stricto*, though one species of *Ichthyotænia*, *I. gabonica*, shows certain points of likeness to both. It is possible, however, that in a revision of the family Ichthyotæniidae, *Ichthyotænia gabonica* may ultimately be given generic rank. The resemblance, however, is somewhat masked by the artificial opening of the uterus, presumably caused by splitting along a ventral line where the uterus, then swollen with eggs, approaches close to the integument. The slit thus formed is not exactly a concrecence of numerous uterine pores, of which, however, there are plenty of traces in *Solenotænia*; it is largely independent of them—perhaps altogether so. On the other hand,

they may assist in forming the ventral groove or slit. Of this I have not positive evidence one way or the other. This condition is, as I think, to be directly compared with the cases described by Zschokke, whose statements as to their significance have been denied, as I have already pointed out, by others. Details are wanting as to whether Zschokke's types show evidence of the pre-existence of uterine pores in younger stages.

The question of the absence or presence of a separate uterine pore in the Tetraphyllidea is not uniformly answered in the text-books. Thus Sedgwick, in his 'Student's Text-book of Zoology,'* remarks that "in the Bothriocephalidae and other forms (possibly in all Cestodes except the Taeniadæ) the uterus has a special opening of its own on to the exterior." On the other hand, Benham divides the Dibothridiata (containing only the Bothriocephalidae and forms with grooves instead of proper suckers) from the Tetrabothridiata (the rest of the Merozoic Cestoidea) by the occurrence of the uterine pore in the former and its absence in the latter †. Probably the balance of opinion is in favour of the view held by Dr. Benham. Leuckart ‡, however (at any rate in the revised English edition of his work), was apparently of opinion that uterine pores are found in the whole group of the Bothriadæ, by which group he understands "the species which remain after the exclusion of the Taeniadæ," though, as Prof. Braun has pointed out in his account of the Tapeworms in Bronn's 'Thierreichs,' Leuckart admitted that but few species had been examined from this point of view.

Prof. Zschokke, in his most extensive work upon the Cestoidea §, has brought forward certain facts which he regards as pointing to a retention of the Bothriocephalid uterine pores among the higher Tapeworms. This orifice in *Calliobothrium coronatum* || is described as "un enfoncement en entonnoir de la cuticle, auquel correspond un relèvement interne de la paroi de l'utérus." He observes, further, that there is no sign of tearing, and a perfect continuity in the walls of this tube. The orifice is figured ¶ without histological detail. On pl. v. fig. 81 of the same memoir is represented the corresponding pore of another species, *C. leuckarti*, also without histological detail, and of it a similar description is given. In another species also a uterine aperture is said to be formed when the contained ova are ripe. Of *Onchobothrium uncinatum* the same fact is stated **. In the genus *Anthobothrium* †† a similar uterine pore is stated to exist in the ripe uterus; but

* Vol. i., London, 1898, p. 249.

† A Treatise on Zoology, edit. by E. Ray Lankester, pt. iv. London, 1901, pp. 116 & 118.

‡ 'The Parasites of Man,' Edinburgh, 1886, transl. by W. E. Hoyle, p. 317.

§ Mém. Soc. Inst. Genev. xvii., 1889.

|| Loc. cit. p. 196.

¶ Loc. cit. pl. iv. fig. 71.

** Loc. cit. p. 250.

†† Loc. cit. pp. 260, 272, 281.

no details or figures are given. Dr. Zschokke has not given any figures of transverse sections through these pores, which are represented in his drawings of them in full face as rather slit-like, and thus suggestive of a tear due to the pressure of eggs. There has been some criticism of the conclusions which I have just briefly abstracted.

Pintner, criticising* these statements as embodied in an earlier paper† of a preliminary nature, definitely denies their truth. "Für sämmtliche mir bekannte Arten," he writes, "der Gattung *Calliobothrium*, für *Anthobothrium musteli*, für *Phyllobothrium gracile*, für *Echeneibothrium* und noch für manche andere von mir untersuchte Tetrabothrieni, trifft das ganz entschieden nicht ‡ zu." Pintner goes on to observe (and his remarks are given by Braun) that a definite slit is formed on the ventral surface of the proglottid shaped like a "gothic door," out of which the eggs pour. This is an artefact due to the internal pressure of the swollen uterus, which lies nearer to the ventral than to the dorsal surface. This slit can be recognised in carefully handled proglottids as a median line. Doubtless, this latter may be a vestige of the uterine opening of the Pseudophyllidea; but that there is no actual natural pore Pintner is satisfied.

The existence of uterine pores has also been dealt with by Kraemer §, and in forms more nearly allied to *Ophidotenia* and *Solenotenia*, viz. in *Ichthyotenia* itself. For to this genus (at any rate *sensu lato*) we are, I believe, to refer *Tenia filicollis*, *T. ocellata*, and *T. torulosa*, the anatomy of which is described by Kraemer. Of the first-named species the author remarks that the eggs are divided by a break in the body-wall, that is to say, through a secondarily appearing uterine opening, which is illustrated by a figure || very like those given by Zschokke and referred to above. A more elaborate account is given of "*Tenia*" *torulosa*. But the secondarily formed slit appears to be formed in the same way as that of the other species, and no suggestion is made that it is in any way a permanent structure, or even a last vestige of the real uterine pore of the Bothriocephalids. Kraemer investigated the slit-like pore by means of sections, and traced it into continuity with the cavity of the uterus, observing (if I understand him rightly) that there is no difference in form which would imply a differentiated duct.

Prof. Braun does not accept the views of Zschokke with reference to a uterine pore ¶ in *Calliobothrium*, etc., and in the

* "Neue Untersuchungen über den Bau des Bandwurmkörpers," Arb. Zool. Inst. Wien, viii. 1889, p. 6 (of memoir) footnote.

† "Studien über den anatomischen und histologischen Bau der Cestoden," Centralbl. Bakt. u. Paras. Bd. i.

‡ Italics, author's.

§ "Beiträge zur Anatomie und Histologie der Cestoden der Süßwasserfische," Zeitschr. wiss. Zool. lii. 1892, p. 647.

|| Loc. cit. Taf. xxviii. fig. 42.

¶ Bronn's Klassen und Ordnungen des Thierreichs, Bd. iv. Abth. 1 B, p. 1441.

systematic list of families and genera distinguishes the Tetraphyllidea from the Pseudophyllidea by the character (among others) "Keine praeformierte Uterusmündung" *; and again, with reference to the Cyclophyllidea † uses as part of his diagnosis the words "Keine Uterusöffnung." Nothing can be more definite than these statements, which appear to express the general opinion upon the matter. In detailed criticism Braun points out that the alleged uterine pore differs in its position in various proglottids, which is not consonant with the idea of a fixed and definite structure. He points out, further, that the constancy of what he considers to be merely a point of rupture to the ventral surface is associated simply with the ventral situation of the uterus, and perhaps, furthermore, reminiscent of the ancestral and ventrally situate uterine pore. Prof. Max Braun, in fact, entirely associates himself with Pintner's criticisms of Prof. Zschokke.

The statements of so expert a student of Cestodes as Prof. Zschokke must not be passed over without attentive examination. It is to be noted, however, in the first place, that the conditions which he describes and figures in *Calliobothrium* (and allied forms) are different from those which I find in *Ophidotaenia* and *Solenotænia*, and that these observations do not therefore precisely confirm those of Zschokke, though they certainly increase their probability on general grounds. It may be that Zschokke's two figures refer to a stage comparable to that which I have figured in a comparatively young proglottid of *Ophidotaenia russelli* ‡. I am not, however, disposed to think that this is the case, for the same state of affairs exactly appeared to occur in all of the many species enumerated by Zschokke. There would not be this exact repetition were the circumstances as I have described them in *Ophidotaenia*, and in the genus which forms the subject of the present paper. I am, therefore, of opinion that a further study of *Calliobothrium*, *Anthobothrium*, etc., is necessary before they can be accurately compared with *Ophidotaenia* and *Solenotænia*.

At the time when I was occupied with the study of the species of Ichthyotæniids, the results of which have been communicated to the Society, the volume of the 'Zoological Record' published in 1912 had not come into my hands. I regret, therefore, to have missed a preliminary notice § by Mr. G. La Rue of a forthcoming revision of the Ichthyotæniidae (or, as he terms the family, Proteocephalidae), in which an important fact is recorded which I had thought to have put forward for the first time. In the definition of the family Proteocephalidae, the following sentence occurs:—"Uterus median, ventral, with lateral outpocketings, and with one or more preformed ventral openings," and in the description of five new species of *Proteocephalus* (all from fishes), the number of

* Brönn's 'Thierreiche,' loc. cit. p. 1698.

† Loc. cit. p. 1707.

‡ P. Z. S. 1913, text-fig. 35, p. 163.

§ Zool. Anz. Bd. xxxviii, p. 473.

these ventral openings is mentioned; thus, e.g., he writes of *Proteocephalus singularis*, sp. n.: "Uterus with 20-25 lateral pouches on either side and with 2-4 ventral pores." The same statement (save for the actual number of the pores) is made of one species of *Ophiotenia**, a new genus described by the author.

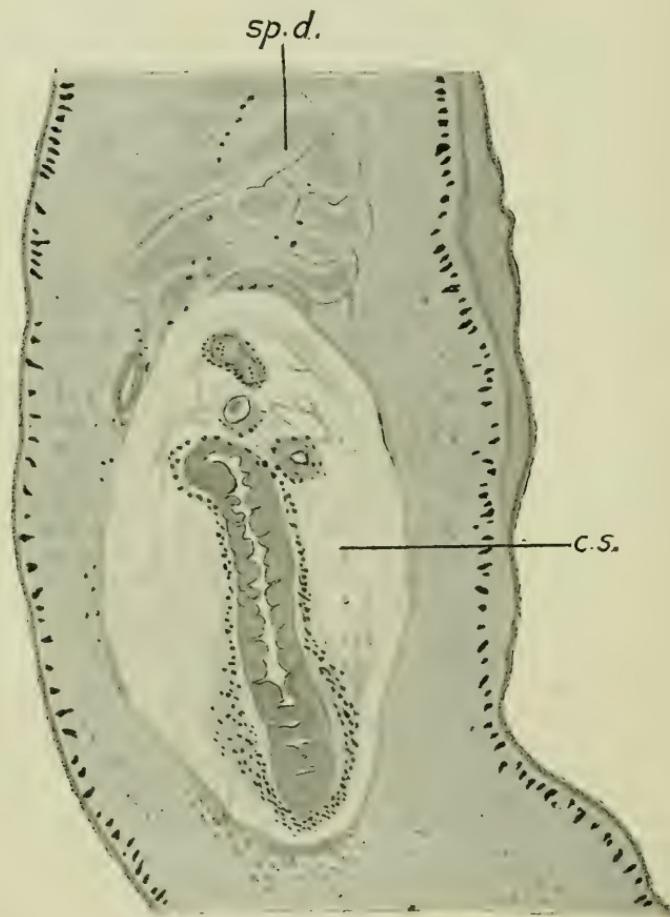
This comprises all that is written in the preliminary note concerning the uterine pores. There is enough, however, as I believe, to prove that Mr. La Rue and myself have observed identical structures; but it is, on the other hand, conceivable that the conditions characteristic of the various species described by La Rue are similar to those which I have described above in *Solenotenia*, and that the "ventral openings" of the uterus may be merely the commencement of ruptures which end in fusing together and forming a ventral groove. This view would account for the variable number of the openings in a given species, of which I have quoted an instance above.

The testes of this species are very numerous, and really extend quite across the body except for the middle region occupied by the uterus, and this is relatively quite narrow. Posteriorly the testes reach the ovary, and are found at the side of that gonad which is not greatly extended laterally. The most posterior region of the proglottid is, however, free of testes; not however the most anterior, for they extend quite to the anterior limit of the proglottid. In younger proglottids, where the uterus is simply represented by a narrow median cord, the testes are more obviously disposed in two lateral bands, leaving a considerable gap in the region of the uterus, which is to be occupied by the latter when fully mature and provided with its diverticula. In mature proglottids I have seen quite ten testes on either side of the uterus; but they are not arranged in regular rows. The coil of the *vas deferens* before it enters the cirrus-sac is denser than I have seen it in some allied forms. The coil extends quite to the uterus, and the lumen of the tube is wide. The *cirrus-sac* (text-fig. 53) seems hardly to possess a definite wall of its own. The wall of the cavity in which the coiled cirrus lies is practically a layer of the network of the medullary parenchyma. This region of the cirrus-sac is hardly wider than that situated nearer to the external pore. Further in the latter direction the bands of longitudinal muscle-fibres come to lie actually on the wall of the cirrus where, however, they are obviously merely adventitious and undergo no modification, such as increase in thickness, to assist in the protrusion of the cirrus. The cirrus-sac is not so markedly flask-shaped as it is in many other Cestodes; but there is a narrower neck region towards the external pore. This region has marked but not very thick muscular walls, in which the fibres trace a more or less circular direction, thus forming a

* I do not know whether this genus is exactly coextensive with my genus *Ophiotenia*. The preliminary definition given of *Ophiotenia* is not sufficient. The accidental similarity of names is a coincidence which might well have been expected.

constrictor; but I am not able to assert whether this is or is not a local modification of the general longitudinal layer of the body. The interior of the cirrus-sac is packed with a delicate fibrous

Text-fig. 53.



Transverse section through a portion of a proglottid of *Solenotenia viperis*, showing the cirrus-sac, *c.s.*, which is seen to have no definite walls. In the interior of the sac is shown the terminal wider part of the cirrus and three sections of the narrower part of that tube. *sp.d.* Coiled region of sperm-duct.

network, with elliptical or spherical interspaces, which seems to me to present no differences from the general parenchyma of the body. The *cirrus* increases in diameter towards the external

pore, and this thicker proximal region lies straight within the sac. The cirrus is invested with a layer of glandular cells. This layer is continuous with the subcuticular layer of the body. The *male orifice*, as is general among the Ichthyotæniids, is sometimes in front of, and sometimes behind the vaginal pore. There is nothing remarkable about the *ovary* or the *vagina*.

§ Résumé and General Observations.

The foregoing account of the worm *Solenotænia viperis* proves the existence in a New World snake of an Ichthyotæniid, most nearly allied to my genus *Ophidotænia*, which is Old World in range, and at present known only from India. This distributional fact gives at once a certain *a priori* reason for justifying the distinctness of the two genera. I do not, however, attempt to justify my conclusion by the geographical fact only. The large size of the scolex, the peculiar apical sucker, and the ventral groove upon the mature segments seem to me to be sufficient facts to go upon in the present state of our knowledge of the Ichthyotæniidæ. I cannot, however, state the absence of this apical sucker in *Ophidotænia*. The most valid reason is the gaping of the uterine slit to form a ventral groove upon the mature segments. In this respect *Solenotænia* has advanced a stage further than *Ophidotænia*. For while there are traces of separate and pre-existing uterine pores, these are replaced by an opening up (however caused) of a ventral median area of the uterus and integument. This leads the way to—if it be not identical with—the conditions recorded by Zschokke and others in *Calliobothrium* and other genera. It appears to me that inasmuch as my specimens of *Ophidotænia* were furnished with fully mature proglottids (as regards ova and uteri), a ventral slit is not developed in that genus, and is therefore a legitimate character in the definition of *Solenotænia*.

The existence of this ventral uterine slit still further justifies the relationship between the Ichthyotæniids and *Calliobothrium*, and other “Bothriadæ,” and their removal from the Tetracotylea, with which they have been placed, though sometimes only doubtfully. It seems probable that their definite inclusion by Max Braun (in Bronn's ‘Thierreichs’) with the Tetraphyllidea is correct.

21. Zoological Results of the Third Tanganyika Expedition,
conducted by Dr. W. A. Cunnington, 1904-1905.
—Report on the Branchiura. By WILLIAM A.
CUNNINGTON, M.A., Ph.D., F.Z.S.

[Received February 11, 1913 : Read March 4, 1913.]

(Plates XLI.-XLV.*)

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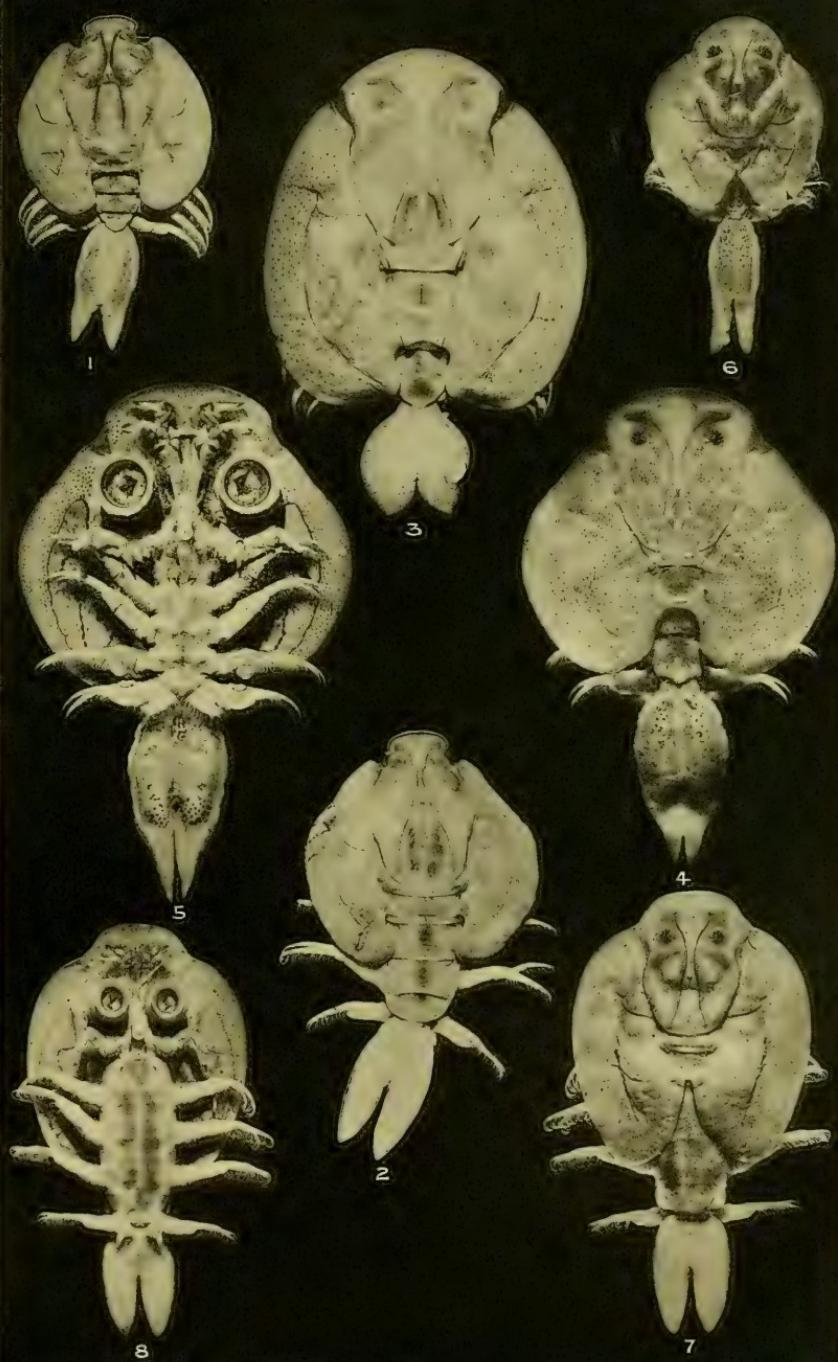
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1. *Introduction.*

Through the collections made by Stuhlmann in Lakes Victoria Nyanza and Albert Edward Nyanza, and by Fülleborn in Lake Nyasa, we have for some time known of the existence of Argulidae in the waters of those lakes. The material collected during the Third Tanganyika Expedition proves that these parasitic copepods also occur commonly in Tanganyika, from which lake, indeed, far more species are now known than from any of the other great African lakes. As many as 363 specimens were obtained by this Expedition, the great majority of them from Tanganyika, with a few from Victoria Nyanza. There are nine species represented in all, and it is interesting to remark that, while two species—both previously described—were found in Victoria Nyanza, the same two forms were associated with no fewer than seven new species in Tanganyika.

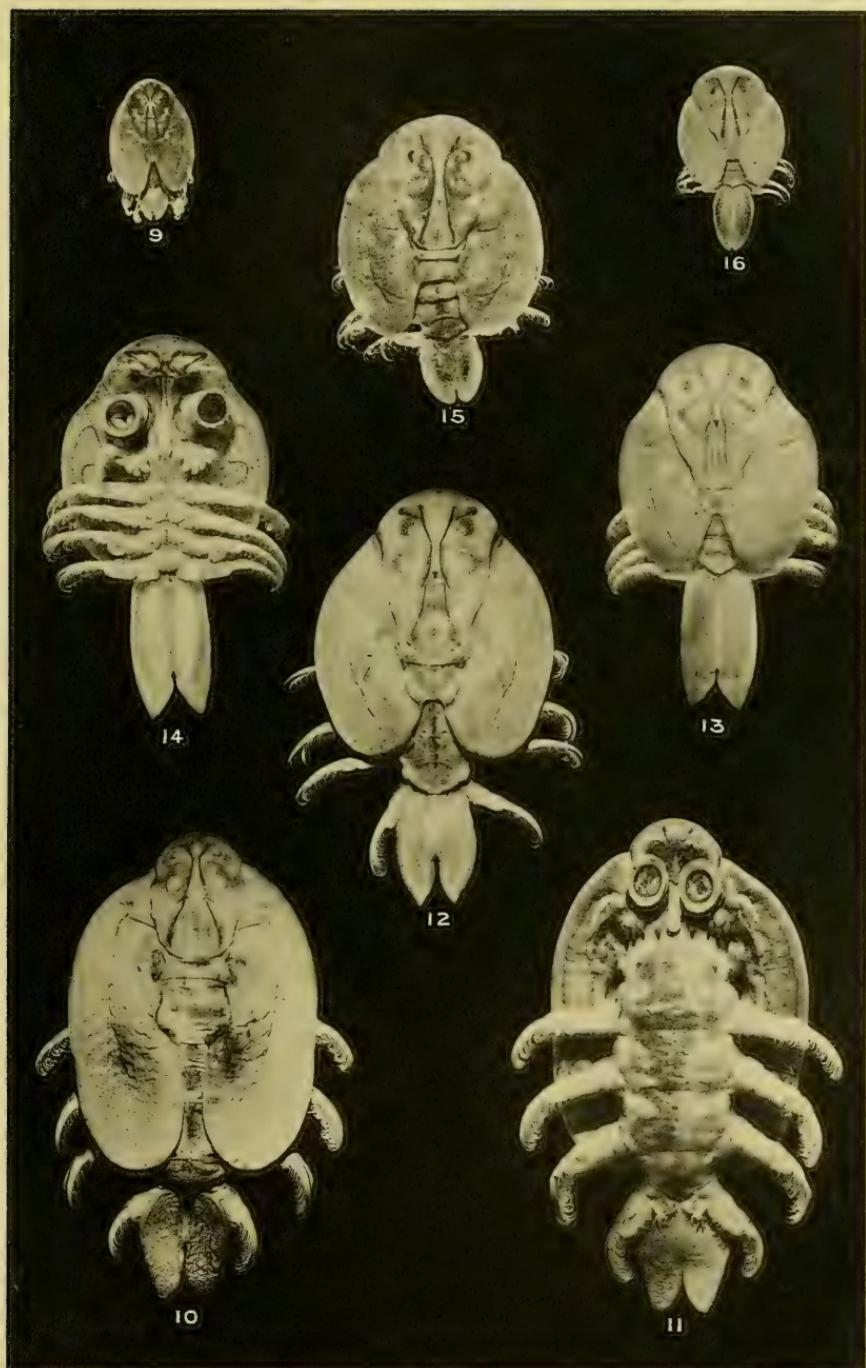
Since the return of the Expedition there have come into my hands specimens of Argulids from Nyasa and from Albert Nyanza; and as these constitute new records and add to our knowledge of distribution, it seems desirable to refer to them also in the present paper. Including the two types collected by Fülleborn in Nyasa, the following is thus a complete list

* For explanation of Plates, see pp. 282-283.



1, 2. ARGULUS INCISUS. 3-5. A. RUBROPUNCTATUS.

6-8. A. PERSONATUS.

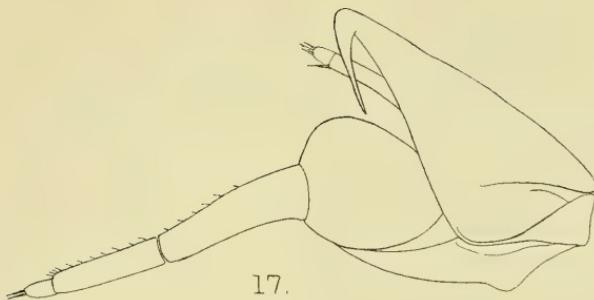


9. *ARGULUS EXIGUUS.*

10, 11. *A. ANGUSTICEPS.*

12-14. *A. STRIATUS.*

15, 16. *A. RUBESCENS.*



17.



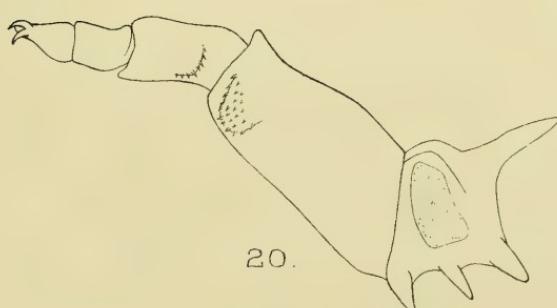
18.

22.



21.

19.



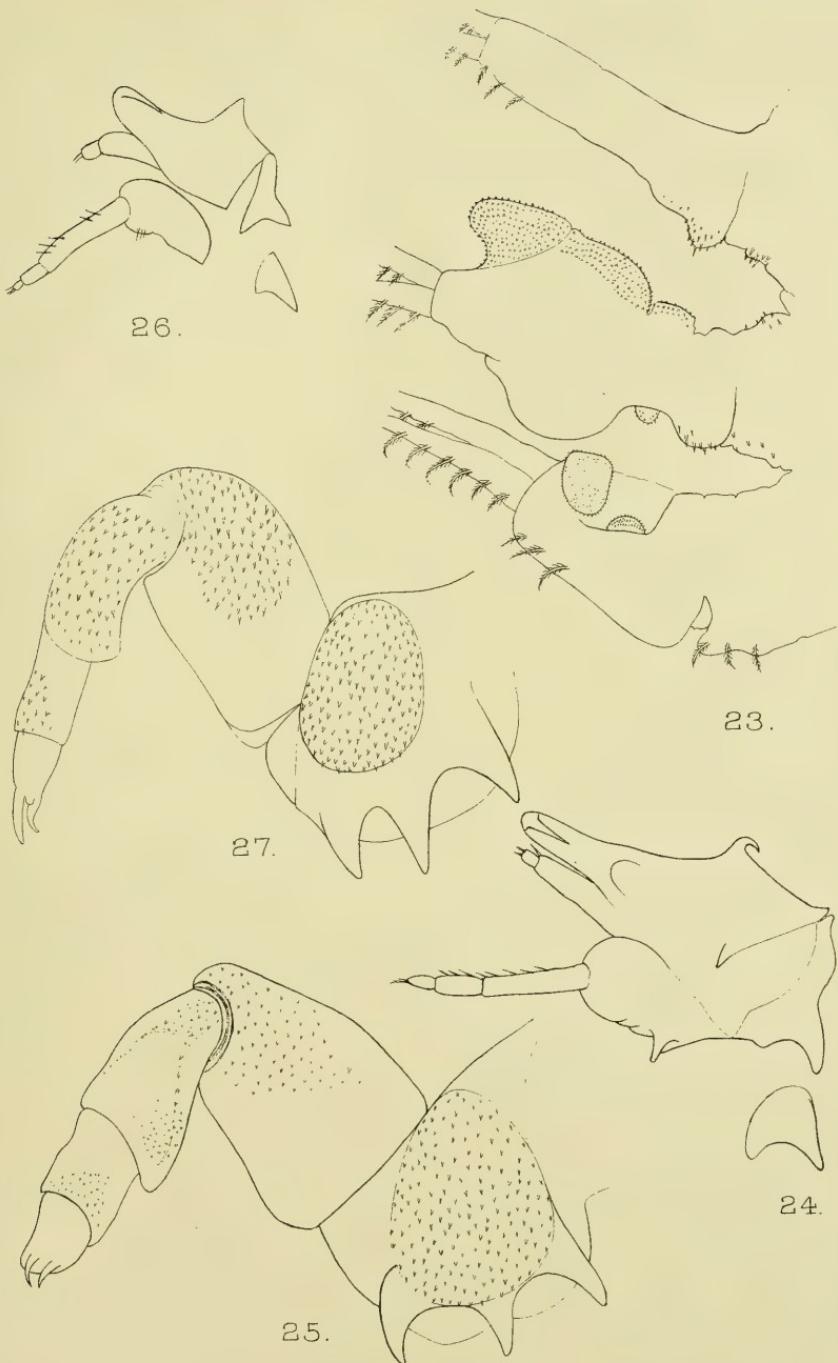
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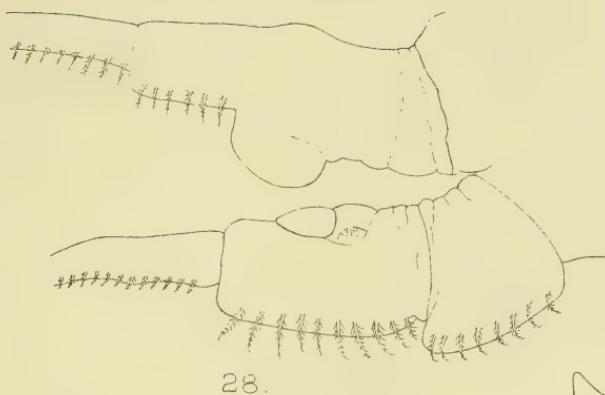
W.A.C. del.

Huth sc. et imp.

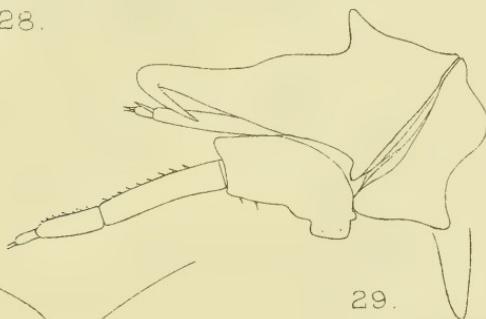
17,18. *ARGULUS INCISUS*. 19,20. *A.RUBROPUNCTATUS*.

21,22. *A.EXIGUUS*.

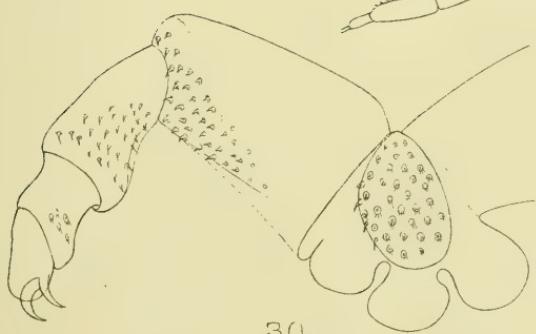




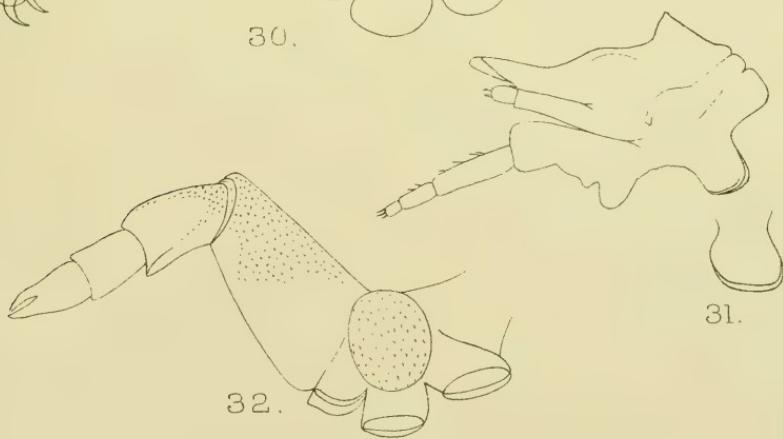
28.



29.



30.



31.

32.

of the species at present known to occur in the lakes in question :—

TANGANYIKA.

- Dolops ranarum* Stuhlmann.
Argulus incisus, sp. n.
 " *rubropunctatus*, sp. n.
 " *personatus*, sp. n.
 " *exiguus*, sp. n.
 " *angusticeps*, sp. n.
 " *striatus*, sp. n.
 " *rubescens*, sp. n.
 " *africanus* Thiele.

VICTORIA NYANZA.

- Dolops ranarum* Stuhlmann.
Argulus africanus Thiele.

NYASA.

- Dolops ranarum* Stuhlmann.
Argulus africanus Thiele.
Chonopeltis inermis Thiele.

ALBERT NYANZA.

- Argulus africanus* Thiele.

By the kindness of Dr. Calman I have been permitted to examine the African specimens belonging to the British Museum. They are of species already known to science, but as, in one instance, they afford a record of a new locality, and as no notice of them has been published, they will be referred to in their place in the systematic part of this paper.

To illustrate the general appearance of the new species, I have made use of photographs taken with a low-power lens from the actual specimens themselves. The difficulties in the way of obtaining reasonably good results from objects which are by no means flat are very considerable, but I think that the photographs in question are really more satisfactory for the purpose than drawings would be. They were made with a special photomicrographic lens in the Zoological Laboratory of King's College, London, and I have to express my indebtedness to Prof. Dendy for allowing me to work in the laboratory, and also to him and to Mr. R. W. H. Row for affording me the benefit of their experience with the apparatus.

2. *Systematic Notes and Description of New Species.*

Family ARGULIDÆ.

DOLOPS RANARUM Stuhlmann.

Gyropeltis ranarum Stuhlmann, Zool. Jahrb., Syst. Bd. vi. 1891, p. 154.

Dolops ranarum Bouvier, Bull. Soc. Philom. sér. 9, tome i. 1899, p. 13.

Dolops ranarum Wilson, Proc. U.S. Nat. Mus. vol. xxv. 1903, p. 737.

Dolops ranarum Thiele, Mitt. Zool. Mus. Berlin, Bd. ii. Heft 4, 1904, p. 17.

This species was originally obtained by Stuhlmann at Bukoba, on the western shores of Victoria Nyanza, and described by him under the name *Gyropeltis ranarum*. The specimens were found attached to the surface, and occasionally at the entrance of the branchial chamber, of a number of tadpoles, and on that account received their specific name. It does not appear a very fortunate title, however, since specimens were obtained by the present Expedition from the bodies of four different kinds of fish, and most of the specimens, as a curious coincidence, actually from Bukoba itself. It is, indeed, no new fact that certain species of Argulidae may be found on a variety of hosts, the well-known European type, *Argulus foliaceus*, being an excellent example, as its host-list also includes frog-tadpoles as well as a number of fish. The literature of the subject contains other cases of similarly inappropriate specific names derived from those of the hosts, and as long ago as 1875 Claus* deprecated this obvious but unsatisfactory manner of naming species.

It may be no more than coincidence, but it is remarkable how often this form was found associated with *Argulus africanus* on a common host.

TANGANYIKA.—*Dolops ranarum* does not appear to be common in Tanganyika, since it was obtained on only one occasion, and then from a single large fish. The coloration of these specimens differs somewhat from that stated hitherto, and, in fact, to some extent from the Victoria Nyanza specimens in the present collection. The upper surface of both carapace and abdomen is irregularly covered by arborescent pigment-spots of a grey colour, which are most numerous on the carapace lobes. In addition, there is an irregular series of small white spots, scattered without any apparent relation to the grey pigment-spots already mentioned.

Occurrence.—Kala, 18/11/04. From mouth-cavity and gill-bars of large *Lates microlepis* (length 910 mm.). Three male and three female specimens. Associated with them were specimens of *Argulus africanus*.

VICTORIA NYANZA.—This is the only species of Argulid hitherto known from the lake, and still seems to be the commonest, although specimens of another widely distributed form (*Argulus africanus*) were obtained during this Expedition. The specimens of *D. ranarum* taken in this lake differ slightly in colour from those collected in Tanganyika. They are of a more uniform brown colour, and show little of the arborescent grey spots above

* Zeitschr. f. wiss. Zool. Bd. xxv. 1875, p. 278.

mentioned, though these are faintly indicated in some cases. The white spots are clearly visible.

Occurrence.—Bukoba, 24/4/05. From surface of body, mouth, and gill-chambers of a large Siluroid (? *Bagrus degener*)—native name, *Nfui*. Ten male and eleven female specimens. A specimen of *Argulus africanus* was associated with these.

Bukoba, 24/4/05. Associated with specimens of *Argulus africanus* from surface of body and inside mouth of large *Protopterus aethiopicus* (length 1040 mm.). Three males and one female.

Bukoba, 24/4/05. From surface of body, mouth, and gill-chamber of large Siluroid (? *Clarias anguillaris*)—native name, *Nshonzi*. Two male and three female specimens. An individual of *Argulus africanus* occurred with these.

A single female specimen in the collection of the British Museum has been more recently obtained from the lake. The particulars recorded are:—"On skin of fish ('*Mālē*') ? catfish. Lake Victoria. Collected by G. D. H. Carpenter, 6. xi. 11." This was associated with specimens of *Argulus africanus*.

NYASA.—I am indebted to my friend Capt. E. L. Rhoades, of the British Naval Service on Lake Nyasa, for a small collection of Argulidae from this lake. The specimens all proved to belong to this species, and not to either of those obtained by Fülleborn in the lake. They are thus an addition to the number of forms known in Nyasa, and at the same time a record of still wider distribution of the species. There are two male and four female specimens, the only particulars given on the label being:—"Fish-lice, ex. '*Sungava*': Lake Nyasa, 1908."

RIVER NILE.—In the British Museum collection are six male and ten female specimens from yet another new locality. With them was associated a single female specimen which I place, with some hesitation, under *Argulus africanus*. They were obtained by Mr. L. Loat, who gives the following details:—"Parasites out of the mouth of a large '*Hala*' (*Heterobranchus bidorsalis*), caught at the mouth of Lake No., White Nile, Jan. 30, 1901."

Genus ARGULUS.

All the remaining Argulids in the collection belong to the genus *Argulus* itself. The number of species included in this genus is fairly considerable, yet they are, on the whole, reasonably distinct, and there seems to be no grounds for subdividing the genus. As the number grows, it becomes at the same time a matter of increasing difficulty to diagnose a species accurately, save at some length, since the differences are often of a minor nature, concerning numerous parts of the external anatomy. These facts render it more than ever difficult to offer to other workers in this field a satisfactory key to the species.

Wilson *, in 1903, made a serious attempt to provide a key to

* Proc. U.S. Nat. Mus. vol. xxv. 1903, p. 701.

the whole of the then known species of *Argulus*, but without achieving a great success. He was unfortunate in choosing for the purpose certain characters which clearly depend upon the state of contraction of the specimen and, in addition, are difficult to distinguish with exactness. It is not easy, for example, to determine how far the swimming-legs are covered by the carapace, as this is influenced by the relative states of contraction, as well as by any chance displacement. Again, while it is easy in extreme cases to point out forms in which the carapace lobes overlap, or do not reach the abdomen, it is virtually impossible to distinguish accurately those with "Carapace lobes just reaching the base of the abdomen." Most keys are open to the objection that they are purely artificial, and Wilson, it is true, fully admits the artificiality in this case. Nevertheless, a key in which in so many cases male and female specimens of the same species are separated under merely arbitrary standards, falls very short of what is to be desired.

It is certainly a matter of great difficulty in this genus to discover characters which satisfactorily lend themselves to the purpose of key-making. Where male and female differ markedly in external shape, as is sometimes the case, it seems perhaps inevitable that the sexes should be artificially separated; but this might be avoided to a greater degree than has been done by Wilson. While objecting to the form of the key above mentioned, we feel that Wilson is to be commended for attempting to tabulate the species; and since he included all the then-known forms, it at first seemed wise to incorporate in his key the seven new species described in this paper. It was on going into the matter with this end in view that the unsatisfactory features already mentioned revealed themselves, and, in addition, certain regrettable inaccuracies* which only added to the difficulties of incorporation. Under these circumstances it was finally decided to prepare a key to include only the African species; and this is the more desirable, since the one species of this genus hitherto known from the continent is now increased to eight.

Before proceeding to give the key and the descriptions of new species, a few words of caution may be offered. The characters employed in diagnosing the forms belonging to this group, while perhaps the most obvious, are in some cases profoundly influenced by artificial contractions and contortions, and in addition by the age of the individual. Proportions of length to breadth are seldom quite constant, size of suckers may vary with degree of expansion, and certain spines and processes may be more

* *Op. cit.* p. 702. On this page, for example, under the heading 6., *A. niger* is said to have an "abdomen narrow, ovate." Under the heading 7., *A. pugettensis* is contrasted with this as having "abdomen wide, elliptical." Actual measurements of both these species are given in the body of the work, and may be written breadth over length as follows:—*niger* $\frac{3.25}{4}$, *pugettensis* $\frac{4}{5.3}$. Expressing these in the form of percentage of breadth to length, they become:—*niger* 81.2, *pugettensis* 75.4. Thus it is evident that the abdomen of *niger*, described as "narrow," is in reality broader than that of *pugettensis*, described as "wide."

prominent in some individuals than others. An extensive series of measurements undertaken by the writer has shown that, while sizes and proportions may be stated in general terms, a considerable degree of variation is commonly met with, and that young specimens as a rule deviate somewhat from the normal specific characteristics.

Concerning the actual figures given in the specific descriptions, it is to be noted that the proportions are not always precisely those adopted by Wilson. The latter gives the relative length of the abdomen as a fraction of the entire length of the animal *exclusive of the abdomen*. This has seemed to me less satisfactory than to express it as a fraction of the *total* length of the animal. What is wanted is to indicate briefly what proportion of the total length is constituted by the abdomen, and this mode of expression has therefore been chosen in the following descriptions.

Again, in the matter of the suckers it seems likely that Wilson's fractions are not strictly comparable with those given in this paper, although the same plan has been adopted of expressing the size as a proportion of the breadth of the carapace. My earlier sucker measurements were all made on a basis of the over-all diameter contrasted with the carapace breadth. They gave decimal fractions which seemed to vary somewhat erratically, and it was, moreover, most difficult to decide what might be legitimately considered as the edge of the sucker in an average state of expansion. The well-marked chitinous ring to which the membranous border of the sucker is attached seemed to offer a much more definite structure for investigation, the dimensions of which could be clearly observed. A further series of measurements, in which the size of this chitin ring was taken as a standard of comparison, gave results, when expressed in fractions, which were distinctly more uniform; and this method has consequently been adopted for arriving at the figures given in the specific descriptions. The diameter of the suckers and the corresponding decimal fractions are both smaller, of course, than if the over-all dimensions had been taken; and as the figures obtained are smaller, on the whole, than those given by Wilson, it appears highly probable that his are based on the maximum diameter of the suckers.

Key to the African Species of Argulus.

- a. Carapace orbicular, about as long as broad.
 - b. Antero-lateral depressions very pronounced; no accessory spines or processes behind the antennules and maxillipeds
 - b'. Antero-lateral depressions slight; accessory spines present behind the antennules and maxillipeds
- a'. Carapace elliptical, distinctly longer than broad.
 - b. Basal segment of maxilliped bearing spines.
 - c. Second segment of antennule with anterior hook.
 - d. Abdomen long elliptical, lobes bluntly pointed and separated by moderately broad sinus
 - d'. Abdomen broadly elliptical, lobes obtusely pointed and separated by broad sinus; carapace with characteristic reddish spots.....
 - c. Second segment of antennule without anterior hook.
 - d. Abdomen long elliptical, lobes bluntly pointed and separated by moderately broad sinus
 - d'. Abdomen broadly elliptical, lobes obtusely pointed and separated by broad sinus; carapace with characteristic reddish spots.....

incisus.

rubropunctatus ♂.

personatus.

rubropunctatus ♀.

- c.* Second segment of antennule with anterior spine.
- d.* Abdomen slightly longer than broad, sinus less than one-quarter of its length; eyes very large ... *exiguus* ♂.
- d'.* Abdomen distinctly longer than broad, sinus one-half of its length: eyes and suckers situated close together and far forward *angusticeps* ♀.
- b'.* Basal segment of maxilliped bearing broad processes.
- c.* Abdomen long elliptical, at least one and a quarter times as long as broad.
- d.* Abdominal lobes pointed, sinus one-third or more of length of abdomen; carapace lobes characteristically striated *striatus*.
- c'.* Abdomen broadly elliptical, less than one and a quarter times as long as broad.
- d.* Basal segment of antennule bearing broadly rounded process, second segment with small posterior spine-form process *rubescent* ♂.
- d'.* Basal segment of antennule bearing somewhat rounded spine, second segment with stout posterior spine; carapace with characteristic black pigment-spots *rubescent* ♀.
- a.* Abdomen long elliptical, at least one and a quarter times as long as broad.
- b.* Basal segment of maxilliped bearing broad processes, second segment with small posterior spine-form process *africanus*.

ARGULUS INCISUS, sp. n. (Pl. XLI, figs. 1, 2; Pl. XLIII, figs. 17, 18.)

Description.—Carapace orbicular, about as long as broad, with antero-lateral depressions very pronounced, so that portions of the antennae may be visible from above. Posterior lobes broad and rounded, only covering bases of first and second swimming-legs, and separated by a broad sinus about one-fifth the length of the carapace. The edge of the carapace below is only moderately armed with small spines, which extend to the region of the swimming-legs. There are no such spines in the anterior region in front of the eyes. Abdomen in the male twice as long as broad, about two-fifths * entire length of body; posterior lobes pointed, and separated by broad sinus two-fifths length of abdomen. Abdomen in the female more than one and a half times as long as broad, about one-third entire length of body; posterior lobes bluntly pointed and separated by broad sinus one-half length of abdomen. The furcal appendages in both sexes lie at the bottom of the anal sinus. Antennules and antennæ small and ill-armed, approaching closely to one another in the mid line. The second segment of the antennule only is armed with an inconspicuous anterior spine and slender lateral hook. No accessory spines or processes close behind these appendages. Eyes rather large, in the males less than one-quarter, in the females less than one-fifth breadth of carapace apart, and situated somewhat far forward. Suckers rather large, in the males ·14·15, in the females ·15† of breadth of carapace. Maxillipeds of moderate size, rather poorly armed; basal segment produced into three flattened processes; “area”

* Proportions not to be confused with those given by Wilson and differently expressed, *vide supra*.

† Diameter of sucker measured at chitinous supporting ring and not at extreme edge.

rather large, roughly pear-shaped and armed with small spines. No accessory processes are present between the bases of the maxillipeds. Flagella present on the first two pairs of swimming-legs. In the male, vesicula seminalis present on the third leg, copulatory peg and accessory cushion on the fourth. In the female, basal segment of fourth leg produced postero-laterally into pointed lobe. Colour (in spirit) light brown, the testes covered above by large irregular blotches of dark brown.

Dimensions as follows :—

Adult male (largest specimen). Adult female (largest specimen).

	mm.		mm.
Total length	7·3	Total length	11·6
Length of carapace ...	4·1	Length of carapace ...	6·2
Breadth of carapace... .	4·3	Breadth of carapace... .	6·7

Remarks.—The most striking characteristic of this species is the unusually deep antero-lateral depression or sinus, which gives occasion for the specific name. This feature does not occur in any other of the African species—a fact which naturally suggests that excessive shrinkage might be the sole cause. Such an explanation is obviously impossible in this case. The specimens were all of them taken from a single fish, in association with *A. striatus*, but the species were not distinguished on the spot, and all the specimens were treated alike and were brought home in the same bottle. On examination, the deep antero-lateral incision first afforded a palpable distinction between the forms, which proved to be specifically different to a marked degree. Another important feature in which this type differs from the other African species, and indeed from the great majority of the known species, is the complete absence of accessory spines or processes behind both the antennules and maxillipeds.

Occurrence.—Rumonge, 16/2/05. From mouth and surface of body of large specimen of *Auchenoglanis occidentalis*, var. *tanganicanus*. Ten males and thirteen females, some ovigerous. These were associated with a large number of specimens of *Argulus striatus*.

ARGULUS RUBROPUNCTATUS, sp. n. (Pl. XLI. figs. 3–5; Pl. XLIII. figs. 19, 20.)

Description.—Carapace in the male orbicular, slightly broader than long; in the female elliptical, slightly longer than broad. Antero-lateral depressions slight. Posterior lobes broad and rounded, covering bases of all but fourth swimming-legs, and separated by a broad sinus about one-fifth the length of the carapace. The edge of the carapace below is well armed with small spines, which extend into the region of the swimming-legs. Abdomen in the male nearly two and a half times as long as broad, about three-sevenths entire length of body; posterior

lobes pointed and separated by fairly broad sinus one-half length of abdomen. Abdomen in the female as long as or slightly longer than broad, less than one-fourth entire length of body; posterior lobes obtusely pointed and separated by broad sinus almost one-half length of abdomen. The furcal appendages in both sexes lie at the bottom of the anal sinus. Antennules of moderate size, basal segment with stout posterior spine; second segment with stout anterior hook and rather slender lateral hook. Antennæ with stout spine on basal segment. Immediately behind the insertion of the antennule is situated a stout accessory spine. Eyes somewhat small, about one-quarter breadth of carapace apart. Suckers in the males rather small, 12–14 of breadth of carapace; in the females rather large, 15–16 of breadth of carapace. Maxillipeds fairly strong and moderately armed; basal segment produced into three stout spines; "area" of moderate size, oval shape, distinguished by red-brown pigment, but only sparsely armed with spines. A pair of stout accessory spines is situated between the bases of the maxillipeds, and a second pair a short distance behind them. Flagella present on the first two pairs of swimming-legs. In the male, vesicula seminalis present on the third leg, copulatory peg and accessory cushion on the fourth. In the female, basal segment of fourth leg produced postero-laterally into sharply pointed lobe. Colour (in spirit) light brownish grey, covered by an irregular series of red-brown spots, which in part are aggregated together to form definite blotches. Testes covered by irregular blotches of the same pigment.

Dimensions as follows:—

Adult male (largest specimen). Adult female (largest specimen).

	mm.		mm.
Total length	12·2	Total length	10·6
Length of carapace ...	7·1	Length of carapace ...	8·1
Breadth of carapace... .	7·7	Breadth of carapace... .	7·4

Remarks.—This species affords a good example of the striking differences in form of male and female specimens which are not uncommon, although extremely inconvenient for incorporation in any key. Both the shape and dimensions of the carapace, as well as the nature of the abdomen, are markedly dissimilar in the two sexes. While the red spots and blotches are certainly characteristic of the species, it must be admitted that they are not equally obvious on all specimens. They show little on certain specimens in the collection, which are uniformly of a darker brown colour, and they are less conspicuous on young individuals. The posterior lobes of the carapace, especially in the female, may sometimes nearly meet in the middle line, thus, of course, altering the shape of the sinus and also covering the bases of the fourth swimming-legs.

Occurrence.—Kibwesi, 19/12/04. From surface of head (one

specimen on eyeball) of very large *Lates microlepis* (length 1340 mm.). Thirteen male and five female specimens.

Maswa, 15/1/05. Mostly from the surface of the body of a number of *Lates microlepis*. Fifteen males, seven females.

Ndanvie, 8/2/05. From surface of head and body of large specimen of *Lates microlepis*. Seventeen males, three females.

As will be seen from the above, this form has always been found infesting specimens of *Lates*, and never in association with any other species of Argulid.

ARGULUS PERSONATUS, sp. n. (Pl. XLI. figs. 6-8; Pl. XLIV. figs. 23-25.)

Description.—Carapace elliptical, longer than broad, with rather pronounced antero-lateral depressions. Posterior lobes broad and rounded, covering bases of all but fourth swimming-legs: in a female distended with eggs the third swimming-legs are only partially covered. The lobes are separated by a moderately broad sinus, about one-fifth the length of the carapace or sometimes more. The edge of the carapace below is well armed with very small spines, which extend to the region of the swimming-legs. Abdomen in the male two and a half times as long as broad, about two-fifths entire length of body; posterior lobes bluntly pointed and separated by moderately broad sinus two-fifths length of abdomen. Abdomen in the female about one and a quarter times as long as broad, more than one-quarter entire length of body; posterior lobes bluntly pointed, and separated by moderately broad sinus more than one-half length of abdomen. The furcal appendages are small and inconspicuous and lie at the bottom of the anal sinus. Antennules of moderate size, basal segment with stout posterior spine; second segment with small anterior hook, posterior spiniform process, and lateral hook of medium size. Antennæ with small spine on basal segment. Immediately behind the insertion of the antennule is situated a stout accessory spine. Eyes rather large, about one-quarter breadth of carapace apart. Suckers of moderate size, in the males 13-15, in the females 10-18 of breadth of carapace. Maxillipeds strong and well armed; basal segment produced into three stout spines; "area" large, pear-shaped, and armed with small spines. A pair of stout accessory spines is situated between the bases of the maxillipeds, and a second pair, rather slighter, a short distance behind them. Flagella present on the first two pairs of swimming-legs. In the male, vesicula seminalis present on the third leg, copulatory peg and accessory cushion on the fourth. In addition, a small backwardly directed process is present near the base of the second leg, and a considerable conical projection on the anterior face of the third leg. In the female, basal segment of fourth leg produced postero-laterally into pointed lobe. Colour (in spirit) light yellowish brown, the testes covered by irregular blotches of darker brown.

Dimensions as follows :—

Adult male (largest specimen). Adult female (largest specimen).

	mm.		mm.
Total length	6·6	Total length	11·4
Length of carapace ...	3·8	Length of carapace ...	7·0
Breadth of carapace...	3·4	Breadth of carapace...	6·0

Remarks.—While exhibiting no very outstanding characteristics, this species is sufficiently well defined by a number of minor differences affecting several parts of its external anatomy. There are only a few specimens in the collection, and, as is usual, the small ones differ to a certain degree from the large. In the smaller specimens the antero-lateral depressions are less pronounced, and the anterior hook on the antennules is less marked or even absent.

In default of a name more obviously suggested by its anatomy, the mask-like appearance of the carapace is alluded to in its specific name.

Occurrence.—Ndanvie, 7/2/05. From mouth-cavity of several specimens of *Bathybates ferox*. Three males, two females.

ARGULUS EXIGUUS, sp. n. (Pl. XLII. fig. 9; Pl. XLIII. figs. 21, 22.)

Description.—Carapace (in the male) elliptical, considerably longer than broad, with slight antero-lateral depressions. Posterior lobes moderately broad, rounded, covering bases of all swimming-legs, and separated by moderately broad sinus one-third the length of the carapace. The edge of the carapace below is armed with small spines which extend to the region of the swimming-legs. Abdomen in the male slightly longer than broad, about one-quarter entire length of body; posterior lobes bluntly pointed and separated by moderately broad sinus almost one-quarter length of abdomen. The furcal appendages lie at the bottom of the anal sinus. Antennules and antennæ rather small, but moderately armed, approaching somewhat to one another in the mid line. Basal segment of the antennule with posterior spine; second segment with blunt anterior spine, posterior spiniform process, and slender lateral hook. Antennæ with slight spiniform projection on basal segment. Immediately behind the insertion of the antennule is situated a stout accessory spine. Eyes very large, a little more than one-quarter breadth of carapace apart and somewhat far forward. Suckers of moderate size, ·13–·15 of breadth of carapace. Maxillipeds strong and well armed; basal segment produced into three stout spines; “area” of fair size, roughly oval, and armed with small spines. A pair of stout accessory spines is situated between the bases of the maxillipeds, and a second pair, rather slighter, a short distance behind them. Flagella present on the first two pairs of swimming-legs. In the male, vesicula seminalis present on the third leg, copulatory peg and accessory cushion on the fourth.

Colour (in spirit) a reddish brown; in one specimen, the testes are covered by irregular blotches of a darker colour.

Dimensions as follows:—

Adult male (largest specimen).	mm.
Total length	2·7
Length of carapace	2·1
Breadth of carapace	1·6

Remarks.—This species is unfortunately only represented by two specimens, both of the male sex. They appear to be adult, however, although they are small, and there seems no reasonable doubt but that they represent a distinct species. The compound eyes are unusually large, and are actually larger in proportion than in the species which has been named *A. megalops*. The swimming-legs in these specimens are so backwardly directed, that the bases of at least the last pair are, strictly speaking, covered by the abdomen and not by the carapace lobes.

Occurrence.—Mpala, 31/12/04. From surface of body of small *Simochromis diagramma*. One male specimen.

Mpala, 31/12/04. From outside body of medium-sized *Haplochilus tanganicanus*. One male.

ARGULUS ANGUSTICEPS, sp. n. (Pl. XLII. figs. 10, 11; Pl. XLIV. figs. 26, 27.)

Description.—Carapace (in the female) elliptical, considerably longer than broad, with antero-lateral depressions well marked. Posterior lobes moderately broad, rounded, covering bases of all but fourth swimming-legs, and separated by a somewhat narrow sinus, more than one-third the length of the carapace. The edge of the carapace below is well armed with very small spines which barely extend to the region of the swimming-legs. Abdomen in the female slightly longer than broad, about one-quarter entire length of body; posterior lobes somewhat pointed but with rounded tips, and separated by moderately broad sinus one-half length of abdomen. The furcal appendages, which are very small and inconspicuous, lie at the bottom of the anal sinus. Antennules and antennæ small, but moderately armed, approaching closely to one another in the mid line. Basal segment of the antennule with posterior spine; second segment with stout anterior spine, posterior blunt spiniform process, and slender lateral hook. Antennæ with slight spiniform projection on basal segment. Immediately behind the insertion of the antennule is situated a stout accessory spine. Eyes large, one-sixth breadth of carapace apart, and far forward. Suckers small, 11 of breadth of carapace. Maxillipeds strong and well armed; basal segment produced into three stout and sharp spines; "area" of fair size, roughly oval, and armed with small spines. Both suckers and maxillipeds are situated unusually far forward. A pair of stout accessory spines is situated between the bases of the maxillipeds, and a

second pair a short distance behind them. Flagella present on the first two pairs of swimming-legs. In the female, basal segment of fourth leg produced posteriorly into pointed lobe. Colour (in spirit) a uniform brown, but somewhat darker in the region of the egg-masses.

Dimensions as follows :—

Adult female (only specimen).

	mm.
Total length	10·7
Length of carapace	7·8
Breadth of carapace	5·6

Remarks.—It is unfortunate that this species has to be described from a single specimen. The latter is, however, an ovigerous female which exhibits a number of distinctive features and cannot be classed with any of the known forms. Prominent characteristics are the narrow head region, rather well marked off, and the large eyes placed close together. The eyes, suckers, and maxillipeds are also situated remarkably far forward. The carapace lobes appear curiously thick and fleshy—an appearance which might possibly be due to shrinkage. The specimen was obtained from an uncommon source, namely, from a basket of small fish, but was attached to none of the latter. Thus, although the specimen may well have been dead, there is no reason for supposing that it was dried up to any extent, and indeed, its general condition seems to preclude such a suggestion.

Occurrence.—Uvira, 5/3/05. Found among a number of small fish of different kinds—at the moment adhering to none. A single female, distended with eggs.

ARGULUS STRIATUS, sp. n. (Pl. XLII. figs. 12–14; Pl. XLV. figs. 28–30.)

Description.—Carapace elliptical, longer than broad, with slight antero-lateral depressions. Posterior lobes fairly broad and rounded, covering bases of all but fourth swimming-legs; in a female distended with eggs, the third swimming-legs are only partially covered. The lobes are separated by a broad sinus one-fifth the length of the carapace. The edge of the carapace below is armed with small spines, which extend to the region of the swimming-legs. Abdomen in the male nearly twice as long as broad, about two-fifths entire length of body; posterior lobes pointed, and separated by broad sinus one-third length of abdomen. Abdomen in the female about one and a quarter times as long as broad, about one-quarter entire length of body; posterior lobes pointed and separated by broad sinus one-half length of abdomen. The furcal appendages in both sexes lie at the bottom of the anal sinus. Antennules of moderate size, basal segment with blunt posterior process; second segment with stout anterior spine, posterior small spiniform process, and lateral hook of medium size. Antennæ with short blunt process on basal segment.

Immediately behind the insertion of the antennule is situated a stout and moderately sharp accessory spine. Eyes rather large, a little more than one-quarter breadth of carapace apart. Suckers, in the males, rather small, 12-14 of breadth of carapace; in the females, rather large, 14-18 of breadth of carapace. Maxillipeds strong and moderately well armed; basal segment produced into three broad rounded processes; "area" of fair size, pear-shaped, and armed with small spines. A pair of accessory processes, also broad and rounded, is situated between the bases of the maxillipeds, and a second pair, rather slighter, a short distance behind them. Flagella present on the first two pairs of swimming-legs. In the male, vesicula seminalis present on the third leg, copulatory peg and accessory cushion on the fourth. In the female, basal segment of fourth leg produced postero-laterally into pointed lobe. Colour (in formol) light brownish grey, sometimes with a pronounced reddish tinge, the lateral and posterior regions of the carapace lobes showing a distinct radial striation, most clearly seen by transmitted light. Testes covered above by irregular blotches of brown pigment.

Dimensions as follows:—

Adult male (largest specimen).	Adult female (largest specimen).
	mm.
Total length	10·2
Length of carapace ...	6·7
Breadth of carapace...	6·1
	mm.
Total length	11·1
Length of carapace ...	7·5
Breadth of carapace...	6·5

Remarks.—It is not unusual among the Argulidae for the posterior carapace lobes to exhibit some striation, which is due, no doubt, to the branching of what Wilson calls the side-pouches of the stomach. This appearance is, however, so outstanding a feature of these specimens, that *striatus* at once suggested itself as a suitable specific name. From the large number of specimens contained in the collection, this would seem to be the commonest, and perhaps the most widely distributed of the Tanganyika species. There are a few small individuals the sexual characters of which are less obvious, and yet others which must be classed as larval forms and do not show the secondary genital modifications typical of the adult.

Occurrence.—Mbete, 25/9/04. From gill-arches and roof of mouth of large male specimen of *Dinopterus cunningtoni* (length 1020 mm.). Twenty-two males and twenty-five females.

Sumbu, 13/10/04. From gill-arches and roof of mouth of large *Clarias robecchii*. One female, associated with specimens of *A. africanus*.

Vua, 29/10/04. From surface of head and mouth of very large female specimen (length 1550 mm., weight 30·6 kilogr.) of a Siluroid (? *Clarias lazera*)—native name *Muomi*. A single male, associated with specimens of *A. africanus*.

Kasawa, 1/11/04. From mouth and gill-bars of large *Dinopterus cunningtoni*. Three male and two female specimens.

Kibwesi, 19/12/04. From head, mouth, and gill-bars of several large specimens of *Chrysichthys brachynema*. One male and one female, associated with specimens of *A. rubescens*.

Rumonge, 16/2/05. From mouth and surface of body of large *Auchenoglanis occidentalis*, var. *tanganicanus*. Sixty-four males and fifty-six females (some larval) associated with specimens of *A. incisus*.

ARGULUS RUBESCENS, sp. n. (Pl. XLII. figs. 15, 16; Pl. XLV. figs. 31, 32.)

Description.—Carapace elliptical, longer than broad, with moderate antero-lateral depressions. Posterior lobes broad and rounded, covering bases of all but fourth swimming-legs, and separated by a broad sinus, more than one-fifth the length of the carapace. The edge of the carapace below is armed with small spines, which extend to the region of the swimming-legs. Abdomen, in the male, nearly one and a half times as long as broad, about two-fifths entire length of body; posterior lobes rounded and only separated by an insignificant sinus one-sixteenth length of abdomen. Abdomen, in the female, slightly longer than broad, about one-quarter entire length of body; posterior lobes rounded and separated by somewhat narrow sinus almost one-quarter length of abdomen. The furcal appendages in both sexes lie at the bottom of the anal sinus. Antennules of moderate size, basal segment with rounded posterior process; second segment with blunt anterior spine, posterior small spiniform process, and lateral hook of medium size. Antennæ with rounded process on basal segment. Immediately behind the insertion of the antennule is situated an accessory rounded process. Eyes of moderate size, a little more than one-quarter breadth of carapace apart. Suckers, in the males, rather large, .15 of breadth of carapace; in the females, of moderate size, .13-.14 of breadth of carapace. Maxillipeds fairly strong and moderately armed; basal segment produced into three broad flattened processes; "area" of fair size, oval shape, and armed with small spines. A pair of accessory flattened processes is situated between the bases of the maxillipeds, and a second pair, rather slighter, a short distance behind them. Flagella present on the first two pairs of swimming-legs. In the male, vesicula seminalis present on the third leg, copulatory peg and accessory cushion on the fourth. In the female, basal segment of fourth leg produced postero-laterally into pointed lobe. Colour (in spirit) reddish, but with lighter areas anteriorly and round the eyes. Testes covered above by irregular blotches of reddish brown.

Dimensions as follows:—

Adult male (largest specimen). Adult female (largest specimen).

	mm.		mm.
Total length	3·5	Total length	5·4
Length of carapace ...	2·3	Length of carapace ...	4·1
Breadth of carapace...	1·9	Breadth of carapace...	3·7

Remarks.—This species, which in some features comes near to the preceding one, may be readily distinguished from it by the rounded nature of the abdominal lobes. The reddish coloration, which is striking in the larger specimens, is less evident or almost entirely absent in smaller ones. All the male specimens in the collection, which are rather small, show little colour, except, of course, the characteristic blotching of the testes. It will be noticed that this form has only been obtained from the Siluroid *Chrysichthys brachynema*, which is itself an endemic species.

Occurrence.—Moliro, 24/10/04. From roof of mouth of fair-sized *Chrysichthys brachynema*. One female.

Kibwesi, 19/12/04. From head, mouth, and gill-bars of several large *Chrysichthys brachynema*. Three males and nine females, associated with specimens of *A. striatus*.

Mrumbi, 27/12/04. From inside mouth and outside body of large *Chrysichthys brachynema*. One male and one female specimen.

ARGULUS AFRICANUS Thiele.

Argulus africanus Thiele, Zool. Anz. vol. xxiii. 1901, p. 47.

Argulus africanus Wilson, Proc. U.S. Nat. Mus. vol. xxv. 1903, p. 727.

Argulus africanus Thiele, Mitt. Zool. Mus. Berlin, Bd. 2, Heft 4, 1904, p. 37.

A preliminary description of this form was given by Thiele in 1901, and was followed by a more complete account with figures in 1904. It is the only species of the genus *Argulus* which had been previously obtained from the continent of Africa, and it still remains the only species known outside the confines of Lake Tanganyika. Thiele speaks of it as a form widely distributed in eastern Africa, and it is now possible to add other localities to those hitherto known.

As I have examined more than 60 specimens from different parts of Africa, perhaps I may add a few remarks in modification of Thiele's detailed description. Between the average male and female specimens there is by no means so clear a contrast as he indicates in the relative proportions of the carapace (cephalothorax). It is a fact, as I have determined by actual measurements, that the carapace of a large female is broader in proportion, and so less closely resembles the male condition, but except in extreme cases of large females contrasted with small males, there is but little difference in this respect between the two sexes.

Again, the carapace lobes in the female are stated to cover the whole of the swimming-legs, leaving but the tips of the last two pairs visible from above. This may, perhaps, be the condition of things in an individual greatly distended with eggs, but is neither normal nor typical. In the great majority of the females in this collection, the tips of all four pairs of swimming-legs project from beneath the carapace, and in a few cases the

bases of the fourth pair of legs are also visible much as in the male.

The proportions of the abdomen are likewise indicated as affording a distinction between the species, yet it appears that, as a rule, the female abdomen is really longer than broad, the measurements agreeing closely with those of the male, though of course the shape is distinctly different in the two cases. While these additional observations slightly modify the account given by Thiele, there can be no reasonable hesitation in identifying the species, which is readily distinguished by the conspicuous pigment spots and the nature of the antennæ and maxillipeds.

TANGANYIKA.—The species is apparently quite common in this lake, as the collection contains more than thirty specimens obtained from various localities. It does not appear to be confined to one host, and it was in some instances found in association with the endemic species of *Argulus*.

Occurrence.—Sumbu, 13/10/04. From gill-arches and roof of mouth of large specimen of *Clarias robecchii*. Four males and four females. A female of *A. striatus* was associated with these.

Sumbu, 20/10/04. From branchial arches and roof of mouth of two smallish specimens of *Clarias robecchii*. Six males and six females.

Vua, 29/10/04. From surface of head and mouth of very large female specimen (length 1550 mm., weight 30·6 kilogr.) of a Siluroid (? *Clarias lazera*)—native name *Muomi*. Five males and five females, with which a single *A. striatus* was associated.

Kala, 18/11/04. From mouth-cavity and gill-bars of large *Lates microlepis* (length 910 mm.). Two females, associated with specimens of *Dolops ranarum*.

Ndanvie, 8/2/05. From surface of head and body of large *Lates microlepis*. One male. Specimens of *A. rubropunctatus* were associated with this.

VICTORIA NYANZA.—From this lake, too, specimens of *A. africanus* were obtained by the Expedition for the first time. All of them, as it happens, were collected at Bukoba, on the western shore, the place at which Stuhlmann first discovered *Dolops [Gyropeltis] ranarum*. Curious to relate they were also associated in every case with specimens of the latter, living with them on a common host.

Occurrence.—Bukoba, 24/4/05. From surface of body, mouth and gill-chambers of a large Siluroid (? *Bagrus degeneri*)—native name *Nfui*. One female specimen, associated with a number of *Dolops ranarum*.

Bukoba, 24/4/05. From surface of body and inside mouth of large *Protopterus aethiopicus* (length 1040 mm.). Four males, five females, associated with *Dolops ranarum*.

Bukoba, 24/4/05. From surface of body, mouth, and gill-chamber of large Siluroid (? *Clarias anguillaris*)—native name

Nshonzi. A single female, associated with specimens of *Dolops ranarum*.

In the collection of the British Museum are other specimens which have been subsequently obtained. They were also associated with a *Dolops ranarum*. The label reads:—"On skin of fish ('Mălă') ?catfish. Lake Victoria. Collected by G. D. H. Carpenter, 6. xi. 11." Five male and fourteen female specimens.

ALBERT NYANZA.—As the result of a rather unusual occurrence, we now know of the existence of Argulidæ in this lake. In a tow-netting from the lake which was placed in my hands for examination by my friend Dr. R. T. Leiper, Helminthologist to the London School of Tropical Medicine, I found very unexpectedly, a young Argulid. The material was collected by Dr. Leiper in July 1907, when he accompanied the expedition despatched to Uganda by the Egyptian Survey Department, and is of special interest at the present time, being the only collection of plankton as yet made in the lake. The tow-netting was taken at the north end of the lake opposite Magungo. While we know of the free-swimming habit of young Argulids, which would render them liable to be taken in the tow-net, it is certainly very exceptional to capture them in this manner, as is evidenced by their complete absence from the extensive series of tow-nettings made during the Third Tanganyika Expedition. It is thus a very happy accident which gives us this additional record.

I believe the specimen to be a male larval form of *A. africanus*. The blunt rounded spines or processes on antennæ and maxillipeds which are characteristic of the adult, are represented by sharper structures in this individual, but I think there is evidence that this is usual in young specimens.

RIVER NILE.—In the British Museum collection, associated with the specimens of *Dolops* obtained by Mr. Loat, and referred to above, there is a single female which I regard as belonging to this species. There are, it is true, points of difference from a typical specimen, yet in view of its general similarity, and since this form is known to occur in the Nile and is commonly found in association with *Dolops*, it seems desirable to place it here. It was taken from the buccal cavity of a large *Heterobranchus bidorsalis*, caught at the mouth of Lake No., White Nile.

3. General Remarks.

With singular uniformity, all the collections made in Tanganyika prove, to a greater or less degree, the unique character of the organisms inhabiting the lake. The Branchiura are no exception to the rule, for, as a result of this Expedition, we now know that while two species are widely distributed in Africa, they are associated in Nyasa with a single endemic form, but in Tanganyika with no less than seven. Thus in this case again, Tanganyika

is shown to possess not only a considerable number of characteristic species, but a much richer fauna than the other great African lakes, with which we may reasonably compare it. In the adjoining table of distribution, these facts are expressed in graphic form.

Table of Distribution.

Name of Species.	Tanganyika.	Victoria Nyanza.	Nyasa.	Albert Nyanza.	Other parts of Africa.
<i>Dolops ranarum</i>	+	+	+	...	+
<i>Argulus incisus</i>	+				
" <i>rubropunctatus</i>	+				
" <i>personatus</i>	+				
" <i>exiguus</i>	+				
" <i>angusticeps</i>	+				
" <i>striatus</i>	+				
" <i>rubescens</i>	+				
" <i>africanus</i>	+	+	+	+	+
<i>Chonopeltis inermis</i> .....	...	...	+
10 species.	9	2	3	1	2

Taking a general survey of the specimens which have been examined, there are a few points which call for mention. Speaking broadly, there is no great disparity in the numbers of the two sexes in the collection. Only in the case of *Argulus rubropunctatus* was there a marked preponderance of one sex, a total of 45 males accompanying 15 females. There were occasional isolated individuals, but both sexes were usually associated on one host. As a rule, females were larger than males, which seems to be commonly the case.

It is difficult to understand why, in certain species, the relative size of the suckers is different in the sexes. The most striking example is that of *A. striatus*, where a series of measurements gave the following results:—Sucker diameter in males 12–14 of breadth of carapace: in females, 14–18 of breadth of carapace. Such a degree of variation cannot, in this case, be merely an index of carapace diversity in the sexes—short and broad, for instance, contrasted with long and narrow—since these males and females are very similar in this respect. As a rule, where we have sufficient evidence to go upon, the male appears to have a smaller sucker in proportion than the female.

Concerning the relations of these forms to their hosts, some further observations may be offered. Both in Victoria Nyanza and Tanganyika, the smaller fish appear to be relatively little infested by the parasites. These were most frequently observed upon large fish, and particularly on Siluroids, the scaleless nature of which must render them especially liable to attack. Large

specimens of the Tanganyika Serranid *Lates microlepis* also usually bore some examples attached to the surface of the head or within the mouth-cavity.

It is commonly considered that these parasites do not constitute a menace to the fish on which they prey. This was equally the impression made in the present instance. Cases have been recorded, however, in which it seems clear that an excessive number of Argulids infesting a fish may actually cause the death of their host. What appeared to be a striking instance of this came to my notice during this Expedition, and certainly merits a few words of description. Nearing the north-eastern shore of Tanganyika one afternoon, after a long voyage, a large fish was noticed floating on the surface of the water. My men fetched it on board, and it proved to be a specimen of the "kavungwe" (*Auchenoglanis occidentalis*, var. *tanganicanus*), absolutely covered with Argulidae. There was literally hardly a spot on the body not infested with the parasites, and in the head region and within the mouth they were positively overlapping and lying on top of one another. Instead of detaching isolated specimens, as had usually to be done, a layer of writhing Argulids could be scraped from most parts of the body. The fish was not only perfectly fresh, but was still feebly making convulsive movements, and one could not resist the conviction that it was succumbing to the fierce attack of such a swarm of parasites. The latter, in this instance, did not all belong to one species. There were specimens of both *Argulus striatus* and *A. incisus*, the last-named species, strange to say, being obtained on this occasion only.

It was no very unusual thing on Tanganyika to discover the bodies of large fish floating far from shore. The crew of my dhow kept a sharp lookout, and made a point of picking them up when possible, as it meant a little addition to their fare, unless the fish were too putrid for even their taste. I never saw Argulidae under these circumstances, except in the case detailed above, but in no other instance was the fish still living. The suggestion nevertheless occurs, that these also may have been victims of such parasites as appear to have caused the death of the *Auchenoglanis*.

No doubt, as is usually the case, the different types of Argulid are not rigidly confined to one host, though they may have a preference for a particular fish. Thus *Argulus rubropunctatus*, taken on different occasions and in different localities, was obtained only from *Lates microlepis*; similarly, *A. rubescens* was found only on *Chrysichthys brachynema*. On the other hand, *A. striatus*, perhaps the commonest and most widely distributed Tanganyikan form, was obtained from a number of hosts, whilst *A. africanus* and *Dolops ranarum*, owing to their extended distribution, clearly have still larger host-lists.

The question suggests itself—do the Tanganyika endemic species infest endemic fish? Since the number of endemic types

of fish in Tanganyika is so great (some 101 out of 115) it is not surprising that they constitute a majority of the actual hosts. Still there is no reason to suppose that there is any significance in such a connection from what we know of the habits of these parasites, and we find, in fact, an endemic *Argulus* living on a widely distributed host, and widely distributed Argulids (*Dolops ranarum* and *Argulus africanus*) living in Tanganyika on endemic fish.

Not infrequently two species were found living together on a common host. It is remarkable that *Dolops ranarum* was almost invariably found associated with *Argulus africanus*. On the only occasion on which the former was obtained in Tanganyika, it was, as usual, accompanied by individuals of the latter. While one is hardly prepared to say that there is a real significance in this association, it is certainly strange that these two widely distributed forms should appear to range together in the localities from which they come. There is no such constancy in the occurring together of other types. *A. rubropunctatus*, though taken on several different occasions, was always found alone.

The question of distribution within the limits of each lake was hardly likely to prove interesting. Apart from forms obtained on a single occasion, there is no evidence that any of the species are confined to a particular region.

EXPLANATION OF THE PLATES.

PLATE XLI.

- Fig. 1. *Argulus incisus* (p. 268). Male, dorsal view. $\times 5\frac{1}{2}$.
- 2. " " Female, dorsal view. $\times 5\frac{1}{2}$.
- 3. *Argulus rubropunctatus* (p. 269). Female, dorsal view. $\times 5\frac{1}{2}$.
- 4. " " Male, dorsal view. $\times 5$.
- 5. " " Male, ventral view. $\times 5$.
- 6. *Argulus personatus* (p. 271). Male, dorsal view. $\times 6$.
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 32. " " Maxilliped. $\times 60$.

22. Notes on Plankton collected across the mouth of the St. Croix River opposite to the Biological Station at St. Andrews, New Brunswick, in July and August 1912. By ARTHUR WILLEY, M.A., D.Sc., F.R.S., F.Z.S., McGill University, Montreal.

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(Text-figures 54 & 55.)

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The marine Plankton of the Atlantic coast of Canada has been examined qualitatively by Professor Ramsay Wright ("The Plankton of Eastern Nova Scotia Waters," 39th Ann. Rep. Dep. Mar. & Fish.: Further Contributions to Canadian Biology 1902-1905. Ottawa, 1907, pp. 1-19, 7 plates); and the Phytoplankton more particularly by Professor L. W. Bailey ("The Marine and Estuarine Diatoms of the New Brunswick Coasts," Bulletin Nat. Hist. Soc. New Brunswick, No. 28, vol. vi. 1910, pp. 219-239, 2 plates).

The estuarine or tidal Zooplankton off the mouth of the St. Croix river does not seem to have received special attention hitherto. As for the quantitative determination of this tidal plankton, and the systematic tabulation of its periodical fluctuations, an endless field of work is offered to the investigator. Samples taken in a tow-net weighted to a depth of 3-5 fathoms

are often very rich in individuals of Copepoda, Cladocera, Diatoms, and Dinoflagellates. The dominant constituent of the plankton at all times is the Diatom, *Coscinodiscus*, which adheres so tenaciously to the bottom of the watchglasses that it obscures the remaining contents. This Diatom genus, together with *Biddulphia*, is recorded as forming the main part of the Phytoplankton in the brackish water of the Weser river (Ch. Brockmann, 1906; see A. Steuer, 'Planktonkunde,' Leipzig and Berlin, 1910, p. 36).

The character of the water in the tract under survey is defined by the predominance of *Coscinodiscus*, and the value or interest of the records accordingly depends upon this circumstance. Of special note in this regard was the occasional appearance of *Fritillaria borealis* Lohmann, an Arctic Appendicularian associated bionomically with the Copepod, *Calanus finmarchicus*. The *Fritillaria* was always more or less damaged by the force of its impact with the tow-net. The *Calanus* was very rare and always immature; each ramus of the fifth pair of legs was bi-articulate instead of being 3-jointed, as it is typically. H. Lohmann ('Die Appendicularien der Plankton-Exped.' 1896, Taf. viii. f. 6, p. 49) has recorded *F. borealis* also from the Antarctic Ocean, but it is not found in the intervening warm regions. L. W. Williams ("Notes on Marine Copepoda of Rhode Island," Amer. Nat. vol. xl. No. 477, Boston, 1906, pp. 639-660) says that *C. finmarchicus* appeared abundantly in tows taken in Narragansett Bay in January, but was found at no other time. Professor Ramsay Wright (*op. cit.* p. 13) says it was very abundant in the earlier part of the summer at Canso. At St. Andrews I noted its occurrence specifically and singly on July 30th and August 5th; the length was 3 mm.

The characteristic and abundant Calanoids at this time were *Acartia clausi* Giesbrecht, *Tortanus discaudatus* Thompson & Scott, and *Eurytemora herdmani* Thompson & Scott. Of these, *A. clausi* was the most abundant; and this is noteworthy, inasmuch as this species was not found at Woods Hole during July and August 1899, although a related species, *A. tonsa* Dana, was one of the commonest copepods in tow taken from the wharf of the U.S. Fish Commission at that station (W. M. Wheeler, "The free-swimming Copepods of the Woods Hole Region," Bull. U.S. Fish. Comm. vol. xix. pp. 157-192. Washington, 1901). L. W. Williams (*op. cit.* 1906) found *Acartia tonsa* abundant throughout the summer in Charlestown Pond, Rhode Island, where it was the predominant copepod in the tow; he also found *A. clausi* abundant in Narragansett Bay in January and February. Thompson and Scott have recorded *A. clausi* from the Gulf of St. Lawrence. It is often coloured with blue spots in pairs below; and it has a large quivering eye with two lenses.

Tortanus discaudatus is characterised by its dark brown caudal furca with variable and unequal rami, the right larger; often

with the basal lobe of the right outer seta enlarged to form a conspicuous process upon the right ramus. Professor Ramsay Wright found it exceedingly common at Canso from the end of July to the middle of August; he offers an explanation of the asymmetrical tail based upon the mode of attachment of the spermatophore (*op. cit.* p. 14). This is very likely correct, but I cannot confirm the statement that the asymmetry is greater in the female than it is in the male. It was not so in my observations at St. Andrews. The species was originally described from the Gulf of St. Lawrence in 1897 (I. C. Thompson and A. Scott, "Notes on new and other Copepoda in Plankton collected continuously during two traverses of the North Atlantic," Proc. and Trans. Liverpool Biol. Soc. vol. xii. 1898, pp. 71-82, pls. 5-7). It was again described as *Corynura bampusii* by W. M. Wheeler, from Woods Hole and Vineyard Sound (*op. cit.* 1901). L. W. Williams (*op. cit.* 1906) first suggested the identity of *Corynura bampusii* with *Tortanus discaudatus*; but he described an allied form, abundant in Narragansett Bay and Charlestown Pond, as a new species, *T. setacaudatus*, differing from *discaudatus*, as it would appear, chiefly in the character of the fifth legs in the female, which carry spines in the former and are without spines in the latter species. The eye of *T. discaudatus* resembles that of *Acartia clausi* and quivers in like manner. It would be worth while to make a biometrical study of its remarkable caudal furca. Length of ♂ 1.75 mm.

Eurytemora herdmani Thompson and Scott, is to be distinguished from allied species of the genus, especially from *E. hirundooides*, by the structure of the fifth legs in the female. Females with ovisac were noted on August 12th; and on the same date, males with the tumefied central part of the right antenna scarlet. L. W. Williams (*op. cit.* 1906) recorded three species from the Rhode Island region: *E. americana*, sp. n., *E. hirundooides*, and *E. herdmani*.

The ebbtide plankton of August 9th was largely composed of *Chætoceras* and *Rhizosolenia*, Tintinnoids, *Synchæta*, *Acartia*, Nauplii, some *Fritillaria borealis*, and the Cladocera: *Evadne* and *Podon*. *Podon* occurred in almost every tow, and often contained mature embryos in the dorsal brood-sac. Professor Ramsay Wright mentions two species of each genus as occurring at Canso (*op. cit.* 1907, p. 13). In the same year, what he claimed to be the first American records of *Evadne nordmanni* Lovén, and *Podon polyphemoides* Leuckart, were made by L. W. Williams ("List of the Rhode Island Copepoda, Phyllopoda, and Ostracoda, with new species of Copepoda." Special Paper, No. 30, 1907. Reprinted from 37th Ann. Rep. of the Commissioners of Inland Fisheries of Rhode Island, pp. 69-79, 3 plates).

Of Dinoflagellates, *Peridinium divergens* Ehrb. was sometimes very abundant. In the peripheral part of the cytoplasm there

were numbers of relatively large, bright red bodies with a variable and irregular contour. These bodies were not mentioned in Doflein's treatise on the Protozoa ; but were duly described by F. Schütt ('Die Peridineen der Plankton-Expedition,' i. Theil. 27 plates. Kiel und Leipzig, 1895). This author calls the red bodies in *P. divergens*, hygrosomes (p. 84), and attributes their formation to similarly shaped plastids, termed hygroplasts (p. 74). He found that their contents are of a fatty nature, blackening with osmic acid and dissolving in ether (p. 85). It is possible that they may exhibit the property of phosphorescence, though I had no opportunity of testing them for this quality.

L. Plate ("*Pyrodonium bahamense*, n. g., n. sp.," Arch. Protistenk. Bd. vii. 1906 ; see Steuer, *op. cit.* p. 307) suggested that the phosphorescence of *Pyrodonium* depended upon the oxidation of the numerous oil-drops at the hinder end. Bütschli mentions numerous fat-drops in *Peridinium divergens*, which, according to Pouchet, often form an annular zone parallel with the transverse groove ; and this same species has been designated the luminous Peridinium of the Gulf of Trieste.

Brachiolaria, the larva of *Asterias*, appeared in the tow from August 10th, and attracted my particular attention on account of the three papilliferous adhesive processes with a median sessile sucker between them, upon the preoral lobe. This Brachiolaria is virtually identical with that of *Asteracanthion pallidus* (= *Asterias vulgaris* Stimp.) as figured by Alexander Agassiz ('Embryology of the Starfish,' 1864 ; see Selections from Embryological Monographs compiled by Alexander Agassiz, Walter Faxon, and E. L. Mark. II. Echinodermata. Cambridge, Mass., 1883). Agassiz stated that *A. vulgaris* reproduces only in the third week of August at his more southerly station.

Behind each of the three adhesive processes, which are called "brachiolarian arms," there is a long tentacle-like process which may be referred to as a bipinnarian arm. As the term implies, the ciliated band is continued upon the bipinnarian arms but not upon the adhesive processes. On the other hand, the hydrocoel, which can be traced forwards from its pore-canal, sends a diverticulum into each of the adhesive processes but not into the bipinnarian arms.

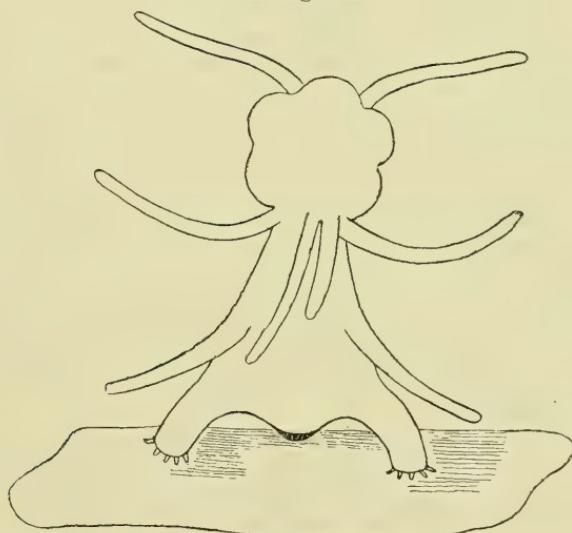
The adhesive processes, or "brachiolarian arms," are structures *sui generis*, but they are paralleled by the three adhesive processes of the Ascidian larva. There is this in common, that they are developed upon the preoral region of the larval body ; they serve for the permanent (Ascidian) or temporary (*Asterias*) fixation of the larva, and they consist of one median dorsal process and two lateral processes. It would be hard to find a closer convergence (parallel adaptation) in the category of adhesive organs. Without presuming that they stand for anything more than physiological adaptations, it seems legitimate to infer that some indirect support, by way of analogy, is given to my interpretation of the

anterior lobe which carries them in the Ascidian larva, as a preoral lobe ("Studies on the Protochordata," 1893, Quart. Journ. Micro. Sci. vols. 34 & 35); a suggestion which the late W. K. Brooks was unable to accept.

Apart, however, from questions of morphology, the comparison between the three adhesive processes of Brachiolaria and those of the Ascidian tadpole cannot fail to be appropriate. I am not aware that it has been made before.

Th. Mortensen ('Die Echinodermenlarven der Plankton-Exped.' 1898) figured the Brachiolaria of the European *Asterias rubens*, and adds that it is so much like that of *A. vulgaris* that a separate description is unnecessary ; but as the one larva occurs on the North American coasts, and the other on the North European coasts, no confusion is possible. I do not know of any data which would enable a distinction to be made between the larva of *A. vulgaris* and that of the associated species, *A. forbesii*.

Text-fig. 54.



Semidiagrammatic view of Brachiolaria attached to a piece of seaweed.

The larva swims through the water with the three anterior bipinnarian arms curving backwards, the remaining eight bipinnarian arms trailing behind. The anterior medio-dorsal adhesive process is directed forwards ; the lateral adhesive processes may be bent forwards or backwards. The median process develops in advance of the lateral processes and is already formed, with its contained branch of the hydrocoel, whilst the lateral processes are represented by rudimentary ectodermal thickenings with a minute projection of the hydrocoel below each of them.

I observed the fixation of the larva to a fragment of red seaweed by means of the adhesive processes, and kept it overnight, alive and attached. The bipinnarian arms became much wrinkled and constricted; the adhesive processes were stretched wide apart so as to allow the median suctorial pad to touch the seaweed between them. The quinque-radiate disc swayed vertically and freely in the water. The accompanying semidiagrammatic sketch (text-fig. 54) will give a better idea of the attached larva than will a verbal description.

A figure from another aspect, after Johannes Müller, of a Brachiolaria fixing itself in a different attitude, is reproduced in the Cambridge Natural History (Vol. i. 1909, Echinodermata, by E. W. MacBride, see p. 613).

I was at first puzzled by the statement in Delage et Hérouard (*Traité de Zoologie Concréte*, T. iii. *Les Échinodermes*. Paris, 1903, see pp. 80–81) that the median epithelial pad, between the bases of the brachiolarian arms, is a ciliated sucker (*ventouse ciliée*), as I had observed no sign of ciliary action upon it. In a subsequent investigation Delage himself found no indication of ciliation of the median suctorial pad (Yves Delage, “*Élevage des larves parthénogénétiques d’Asterias glacialis*,” *Arch. zool. expér.* sér. 4, ii. 1904, see p. 38).

In larvae of *Asterias glacialis* raised by Delage from unfertilised eggs treated with carbonic acid, the paired adhesive arms appeared first, towards the middle of the third month of the culture. Brachiolaria which had reached the fourth month in Delage’s experiments, showed clearly the initial phenomena of the metamorphosis; they ceased to swim, the bipinnarian arms became shrivelled, and the larvae adhered by the mobile brachiolarian arms, occasionally shifting their position.

Amongst the numerous larvae seen by me at St. Andrews, many of which were sketched from life, I only observed the fixation to occur on the part of the oldest, when the asterodisc was most opaque.

The larva does not remain fixed irrévocably at the first spot where it alights upon the bottom; but it never swims again. Therefore it cannot be said that the adhesive arms serve merely for occasional attachment. They represent a definite stereotrophic mechanism.

Bolina.—On August 14th at low tide, about 7 A.M., Dr. Huntsman found quantities of *Bolina alata* at the foot of the wharf, adrift in shallow water. I embraced the opportunity thus afforded of making a fugitive study of this remarkable and fragile Ctenophore which defies all methods of preservation.

L. Agassiz (“Contributions to the Natural History of the Acalephæ of North America.” *Mem. Amer. Acad.*, Boston, 1849) described the various attitudes of *Bolina*, including one in which the characteristic mantle-lobes are spread out lengthwise, at right angles to the secondary axis in which the tentacles lie, and

parallel with the axis of the mouth and polar sensory field. The two pairs of ciliated auricles are a distinctive feature of *Bolina*. The auricles and the reduced inconspicuous tentacles between them occur on either side of this extended pallial axis. When seen from the aboral aspect, as figured by Agassiz, with the lobes flattened out, the organism exhibits a pronounced biradial symmetry, the mouth-cleft and the polar field being parallel to one another in the direction of the longer axis, which coincides with the plane of the flattened stomodæum, whence it is called the stomodæal axis.

In his memoir on *Pleurobrachia*, Agassiz, in spite of some textual confusion, clearly considered the stomodæal axis to correspond with the sagittal axis of bilateral animals, the tentacular axis with the transverse. Later writers continued the discussion.

Korotneff's genus *Ctenoplana*, which I obtained for the second time in New Guinea waters ("On *Ctenoplana*," Quart. Journ. Micro. Sci. vol. xxxix. 1896), seemed to me at that time to be capable of throwing light on this question. Professor Arnold Lang, of Zürich, had compared the Ctenophore with the Polyclade organization, and I, for one, was penetrated with the conviction that biradial symmetry must have preceded bilateral symmetry. It is now clear that there is no such consecutive necessity; and it appears that the dorsiventrality of *Ctenoplana*, approximating it to the facies of a flatworm, is a very interesting piece of convergence.

The question has been re-opened quite recently by Th. Mortensen ("Ctenophora." Danish Ingolf-Exped., Copenhagen, 1912), apropos of the new sessile Ctenophore, *Tjalfiella tristoma* Mrtsn.

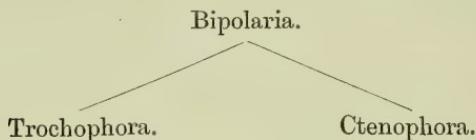
Incidentally Mortensen throws doubt upon the accuracy of my figures of sections showing the peculiar genital ducts of *Ctenoplana korotneffi*; but in so doing he is hardly justified*. I may say, however, that if the morphological comparison between the secondary axes of Radiata (*s. str.*) and the principal axes of Bilateria were not fallacious, then the relations exhibited by *Bolina* would point to the opposite identification to that which I advocated on the basis of *Ctenoplana* (tentacles in the sagittal plane), but to that which Agassiz advanced on the basis of *Pleurobrachia* (tentacles in the transverse plane).

R. Woltereck ("Wurmkopf, Wurmrumpf, und Trochophora,"

* In *Ctenoplana korotneffi* there were four testes only, in two pairs, paired about the tentacle axis. In one individual there were twelve ducts distributed equally among the four testes. Of these ducts I observed the actual opening to the exterior in six instances, in section. In another individual seven ducts altogether were counted in a series of sections.

With regard to the systematic position of *Ctenoplana*, Abbott says "it must be conceded that *Ctenoplana* stands midway between *Cœloplana* and the Cydippid Ctenophores, in regard to its primitiveness or its degeneracy." And again: "The weight of the morphological evidence bears out the conclusion that *Cœloplana* is a very highly specialized Ctenophore derived from the Cydippida." (James Francis Abbott: "The Morphology of *Cœloplana*," Zool. Jahrb., Anat. xxiv. 1907, pp. 41-70, pls. viii.-x. and 7 text-figures.)

Zool. Anz. xxviii. 1904, pp. 273-322), disposing of excellent data, maintained that the change from a radial to a bilateral form is best understood by the transition from the pelagic to the benthonic habit, on the assumption that Bilateria are to be derived from pelagic, radiate, marine animals. He reconstructs, in imagination, the ancestral type of Annelids, as a pelagic, spherical, octoradiate, bipolar Coelenterate, to which he applies the phylogenetic designation: Octoradiata-Bipolaria. His idea of the divergent descent of Ctenophora and Trochophora may be expressed in graphic form:—



Woltereck refers quite simply to *Ctenoplana* as a "creeping Ctenophore." As a creeping Ctenophore its most conspicuous distinctions are a permanent dorsiventrality, the habit of reptation, the presence of pairs of organs, and the possession of a circular mouth. These four qualities are shared by the Polyclade Turbellarians, with bilaterality in addition. Nevertheless, in comparison with the flatworms, these features of *Ctenoplana* are the result of convergence; it is not in the least degree related to the flatworms because of its flatworm habit. To those who have not seen *Ctenoplana* this may have trifling significance; but after seeing it in the living animal, it becomes fraught with meaning, bearing upon the principles and effects of adaptation.

Actinotrocha, the larva of *Phoronis*, appeared in the tow, a solitary example, on August 19th, from about five fathoms. The typical long tentacles were marked with brown pigment; and behind their bases were the small replacing tentacles, indicating that the metamorphosis was at hand. On the preoral lobe or hood, there was a projecting ectodermal knob, a papilla, ciliated and presumably sensory, a little ventral to the apical plate. Such an ectodermal knob on the hood is figured by Marc de Sélys-Longchamps in *Actinotrocha brownei* from Plymouth, England, the larva of an undiscovered *Phoronis*. This larva bears a striking but resemblance to the one at St. Andrews, and I have no doubt but that it is the same species. [M. de Sélys-Longchamps, "*Phoronis*," Fauna u. Flora des Golfes von Neapel, 30th Monograph. Berlin, 1907; see p. 190 and pl. xi. fig. 31.]

In front of the anal peritroch, on the ventral side, was an oblique depression, marking the site of the invagination of the metasome into the interior of the larva.

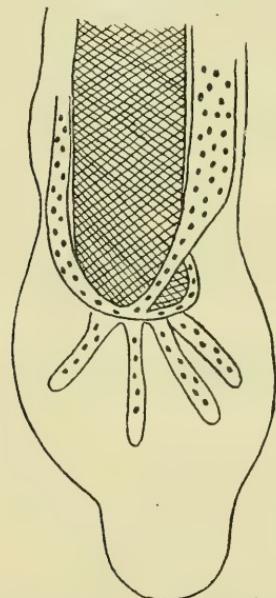
The eversion of the *Phoronis*-body or metasome took place about 3 P.M. in the watchglass. As I had not expected such a

rapid transformation, it happened whilst I was not looking. Brown-coloured débris appeared in the intestine; and the definitive *Phoronis*-tentacles were without pigment.

A conspicuous blood-vessel with red corpuscles traversed the length of the body of the young *Phoronis*, transmitting branches into the tentacles.

The aboral extremity of the body was very mobile, adhering with active, metabolic movements to the glass. Retractile, digitiform, vascular processes, termed cæcal capillaries, were pushed out in rapid succession from the main vessel into the mobile foot-disc and were withdrawn again at frequent intervals (text-fig. 55). I am not aware that the retractility of these first-formed aboral cæcal capillaries has been noted previously.

Text-fig. 55.



Posterior end of a young *Phoronis* immediately after the metamorphosis, showing the retractile vascular processes in the mobile and adhesive foot.

The above-mentioned foot-disc corresponds with the terminal portion only of the ampulla of the fully-formed *Phoronis*. The cæcal capillaries of the ampulla are figured by Sélys-Longchamps in a young individual of *Phoronis sabatieri* (see his pl. viii. fig. 13). This author describes, on p. 35 of his monograph, the special and independent contractility of the terminal portion of the ampulla. The peculiar mobility of this part is associated with a *situs inversus* of the muscular layers, the longitudinal

fibres being external and the circular fibres internal (*op. cit.* pl. v. fig. 4). As a consequence, the lower end of the body exhibits great variability of form, sometimes presenting the same diameter as the rest of the ampulla, at other times dilating to a sphere, and again attenuating to an elongated process. Its special function in the adult is to bury the animal in the mud of the sea-floor.

The function of the foot-disc of the newly-transformed *Phoronis* seems to be the attachment of the body to the substratum. It is desirable to distinguish between a postlarval and an adolescent phase. So far as I am able to judge from the work of M. de Sélys-Longchamps, the peristaltic contractility of the hinder division of the ampulla in the mature or submature *Phoronis* is not identical with the metabolic contractility of the foot-disc in the postlarval phase, when it is associated with, though not in any way caused by, the retractility of the caecal capillaries at this stage. In other words, the formation of the adhesive foot-disc precedes that of the burrowing ampulla.

I believe this is the first record of the occurrence of *Phoronis* on the eastern coast of Canada. No specific description can be based upon a single specimen which has just undergone the metamorphosis; but if my identification of the larva is correct, then the species may be named provisionally *Phoronis brownei*.

In conclusion I desire to acknowledge the kindness and attention which I received from Dr. A. G. Huntsman, the energetic and obliging Superintendent of the Station.

23. Variations in the Skeleton of the Pectoral Fins of *Polypterus*. By EDITH E. BAMFORD, Newnham College, Cambridge *.

[Received January 22, 1913: Read March 18, 1913.]

(Text-figures 56–60.)

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It was suggested to me by Dr. Gadow that the examination of the individual variations of the ample material of young and adult *Polypterus* collected by Budgett in his Gambia and Niger Expeditions, now the property of the Cambridge University, might account for the discrepancies which are found in descriptions of the pectoral fins of *Polypterus*. After examining the material, it becomes evident that these discrepancies are mostly the result of the many individual variations and of the former scarcity of material. A description of the variations found in the ample material at my disposal is of future value;

* Communicated by Dr. H. GADOW F.R.S., F.Z.S.

it can be only a question of time for the ontogeny of this important type of fins to be studied exhaustively, whilst embryological research cannot easily take up the question of the extent of the amplitude of variations.

The material examined consisted of 102 specimens of *Polypterus lapradii* and *Polypterus senegalus*, varying in length from 12 to 43 cm.

Specimens have been previously described by Gegenbaur*, Klaatsch†, Pollard‡, and Budgett§. Unfortunately of larval *Polypterus* only one specimen is known; this was found and described by Budgett. In his description, he says: "The shape of the fin-blade is triangular, the metapterygial border forming with the distal border an acute angle, while the propterygial border forms with the distal border an obtuse angle." None of the specimens I examined had the larval shape; the youngest, 12 cm. long, had already acquired the characteristic form of the adult, the distal border of the mesopterygium being rounded and produced near the metapterygium some distance beyond the latter, thus forming a projection at this place. It seems probable that the peculiar form of the pectoral fin, which has given rise to so much controversy and which caused Gegenbaur and Klaatsch to think it consisted of a stem carrying a biserial arrangement of radials (a biserial archipterygium), is in a large measure due to the partial ossification of the fin and the subsequent unequal rate of growth of the bony and cartilaginous parts, the cartilaginous parts growing more quickly.

The radials showed variations both in number and form:—

I. Variations in Number.

	No. of Fins examined (right or left).	Average number of Radials.	Smallest number of Radials.	Largest number of Radials.
A.	67	16	12	19

	Number of specimens examined.	Specimens with equal number of Radials in right and left Fins.	Greatest difference in number of Radials in right and left Fins.
B.	25	3 (two with 15, one with 16).	4 (12 in the left, 16 in the right).

* Morph. Jahrbuch, Bd. xxii. 1895, p. 119.

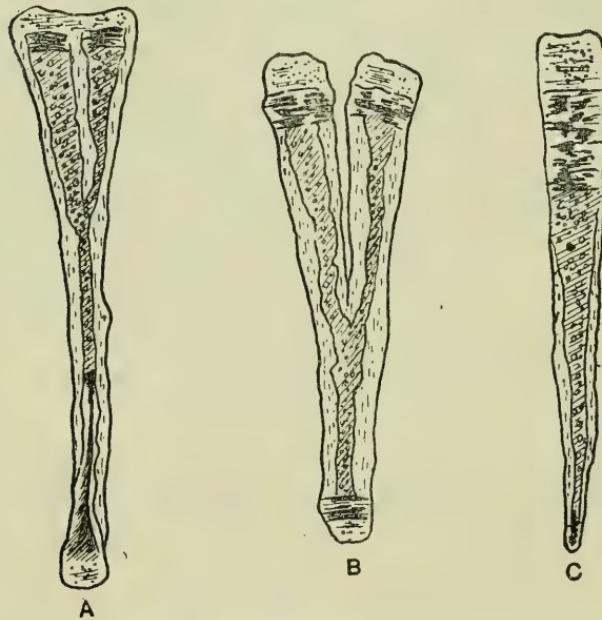
† Festschr. für C. Gegenbaur, Part I. 1896, p. 261.

‡ Zoologische Jahrbücher, v. 1892, p. 387.

§ Trans. Zool. Soc. London, vol. xvi. pt. vii., October 1902.

II. *Variations in Form.*—Some radials were broadened distally (text-fig. 56 A), some had two distal epiphyses, others were more or less deeply forked distally (text-fig. 56 B), and some were incomplete (text-fig. 56 C). A perfect gradation was found from the broadened to the deeply forked radial. In 67 fins examined, it was found that 52 per cent. had either forked or incomplete radials or both variations. Of these, 54 per cent. had forked radials only, 23 per cent. had incomplete radials only, and 23 per cent. had both forked and incomplete radials. The incomplete radials were perfect distally, but had no proximal epiphyses and did not reach to the mesopterygium. There seems

Text-fig. 56.

Radials of *Polypterus*.

- A. Broadened Radial, showing indications of forking.
B. Forked Radial.
C. Incomplete Radial.

to have been some difference of opinion concerning the kind of variation that occurred in the radials. Wiedersheim* showed a dividing radial, but Klaatsch found only incomplete radials in two specimens, and he doubted the occurrence of dividing radials; but that both forms are found (and frequently) is now evident. No forked or incomplete radial is shown in Budgett's larval *Polypterus*.

Judging from the position and shape of the proximal end, an incomplete radial in one specimen appeared to be one of the

* Lehrbuch der vergleichenden Anatomie, Erster Theil, 1882, p. 179.

forks broken off from a forked radial (text-fig. 57 A), but none of the other incomplete radials showed signs of having been derived in this way. It seems highly improbable that the forked radials are two radials fused proximally; the proximal epiphyses and ends are of normal size, the peculiar variation (text-fig. 57 B) where there is probably fusion of two radials shows that forking can occur, for they have divided distally into three. But fusion of radials has almost certainly been found in three fins in the radials next to the propterygium, and these are wide proximally as well as distally. In the table "Fins with Forked Radials only," the one in position 15 seems to be of this kind.

Text-fig. 57.

Radials of *Polypterus*.

- A. Incomplete Radial, apparently formed from one of the forks of a forked Radial.
- B. Radial, probably formed of two fused Radials divided distally into three.

The positions of these forked and incomplete radials on the mesopterygial edge and the relative number of the radials occupying the different positions are of interest. In the tables given below the radials are numbered from the metapterygium, and 1 represents the position of the first radial on the mesopterygium counting from the metapterygium; 3/4 indicates that an incomplete radial is found between radials 3 and 4.

Fins with Forked Radials only.

Position of Forked Radials on Mesopterygium.	Number of Forked Radials found in this position.	Percentage.
1	1	4·5
2	3	13·6
3	8	36·4
4	3	13·6
5	4	18·2
6	1	4·5
12	1	4·5
15	1	4·5

Fins with Incomplete Radials only.

Position of Incomplete Radials on Mesopterygium.	Number of Incomplete Radials found in this position.	Percentage.
3/4	4	50
4/5	2	25
6/7	2	25

In the eight fins where both forked and incomplete radials were found this was their position on the mesopterygium :—

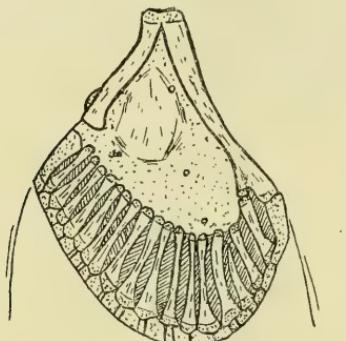
	Forked Radials.	Incomplete Radials.
I.	1 2	3/4
II.	1 2	5/6
III.	3	2/3
IV.	2	4/5
V.	1 3	7/8
VI.	3	5/6
VII.	5	4/5
VIII.	7	3/4

It will be seen that the third radial is most frequently forked and that the incomplete radials most frequently occur between radials 3, 4 and 5. From this position there is a gradual decrease in the frequency of the occurrence of forked and incomplete radials on either side. The region where these forked and incomplete radials are most usually found is the distal projection

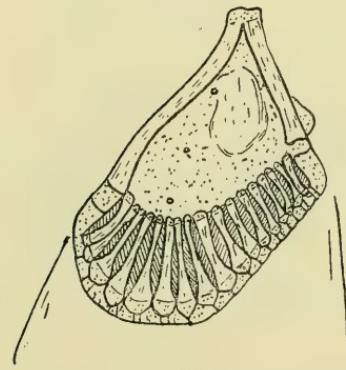
of the mesopterygium, and the most frequent position 3; 3/4 is approximately the apex of the projection.

I found no superficial indications of a former division of the mesopterygial cartilage into a number of blocks, as in *Chlamydo-selachus* and as described by Pollard *. Blood-vessels pass through the mesopterygial foramina, but I found no nerves going through them as indicated in Wiedersheim's † illustration. The

Text-fig. 58.



A



B

Fins of *Polypterus*.

A. Fin with forked metapterygium.

B. Fin with epiphysis of propterygium continuous with mesopterygium, and small cartilage attached to propterygium.

number and arrangement of the foramina vary: from one to six were found, of these one or two occur in the mesopterygial ossification, the rest in the cartilaginous part. The ossified

* *Zoologische Jahrbücher*, v. 1892, p. 416.

† *Lehrbuch der vergleichenden Anatomie*, Erster Theil, 1882, p. 179.

plate in the mesopterygium encloses numerous fat-cells, and branches from the blood-vessels passing through the foramina ramify among them. The left pectoral fin of a specimen 24 cm. long had no indications of an ossified plate, the right pectoral fin being normal. Ossification of the mesopterygium is not always confined to the large ossified plate: I have often seen bone-cells in the proximal cartilage between the converging propterygium and metapterygium, and also occasionally very small ossified plates similar to the large one; calcification of the mesopterygial cartilage in specimens measuring from 21 to 30 cm. is frequent.

The metapterygium showed little variation: one adult *Polypterus* had a forked metapterygium (text-fig. 58A).

Variations were frequent in the distal epiphyses of the propterygium. Klaatsch describes the fin of a young *Calamoichthys*

Text-fig. 59.



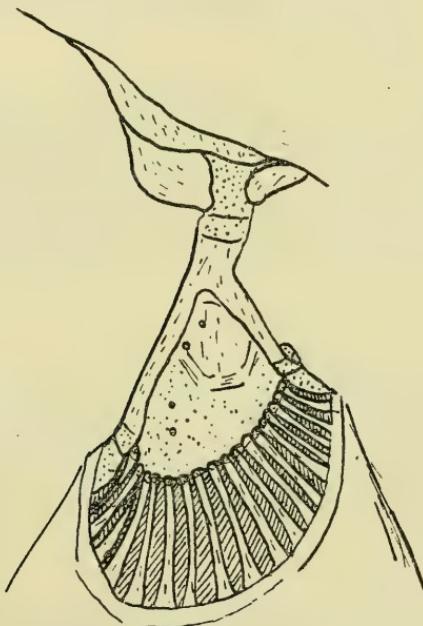
Propterygium of fin of *Polypterus*, with ossified outgrowth and cartilaginous epiphysis in the position of the small cartilage generally found at this place.

18 cm. long, in which the epiphysis is not separated from the mesopterygium, and one 25 cm. long, in which it is separated. He says he has never found this union in a *Polypterus* fin. Wiedersheim's illustration of a *Polypterus* fin shows a distal cartilaginous epiphysis, and succeeding it a piece of cartilage continuous with the mesopterygium. I have very often found the epiphysis of the *Polypterus* fin continuous with the mesopterygium in specimens varying from 13 to 43 cm. in length (text-fig. 58, A, B), but I have never seen a distal epiphysis succeeded by cartilage continuous with the mesopterygium as shown by Wiedersheim. The propterygium in a few cases showed indications of a forking of the ossified distal end.

I can find no explanation of the small cartilage attached to the external side of the propterygium about two-thirds of the length from its base. It is not shown in Budgett's larval form, but in a *Polypterus* 13 cm. long I found it similar to that in the adult. In one specimen, 18 cm. long, there was an ossified outgrowth terminating in a cartilaginous epiphysis at this place (text-fig. 59).

The small distal cartilages have many variations. Usually they alternate with the radials and do not appear to be their terminal segments, as was thought by Gegenbaur when he tried to establish the homology of the radials and the propterygium

Text-fig. 60.



Fin of *Polypterus* with proximal fusion of propterygium and metapterygium.

and metapterygium; but when a multiplication of the cartilaginous segments occurs, as frequently happens, these additional ones are terminal (text-fig. 58, A, B).

In a specimen 35 cm. long the propterygial and metapterygial proximal epiphyses of the left fin were completely united; the propterygium and metapterygium were also completely fused for a distance of 5 mm. This is an interesting variation in support of Klaatsch's theory that the pentadactyle limb is derived from the *Polypterus* type of fin, the humerus being formed from a

fused propterygium and metapterygium *. The articulation with the pectoral girdle was normal, and there were 17 complete and 1 incomplete radials (text-fig. 60). The fin on the right side was typical, the epiphyses only being united; it had 17 radials.

Budgett † has described and illustrated a small flange of cartilage on the external side of the metapterygium in the larval *Polypterus*, which suggests traces of a biserial arrangement of radials on the metapterygium. He says, "On the free edge of the metapterygium, at its distal end, is a slight flange of cartilage, seemingly forming a rudimentary continuation round the distal end of the radial cartilage." I saw no traces of this cartilaginous flange, but on removing the dermal skeleton from the fins I found a flange in the position described, and it was apparently a continuation of the small distal cartilages. But on examining sections it proved to be connective tissue without any cartilage.

24. A Descriptive Study of an Oligochaete Worm of the Family Enchytraeidæ; with an Appendix on certain Commensal Protozoa. By H. H. STIRRUP, B.Sc. (Birm.), Lecturer in Agricultural Biology, East Anglian Institute of Agriculture, Chelmsford ‡.

[Received March 10, 1913 : Read March 18, 1913.]

(Plates XLVI.-XLIX.§ and Text-figures 61-67.)

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INTRODUCTION.

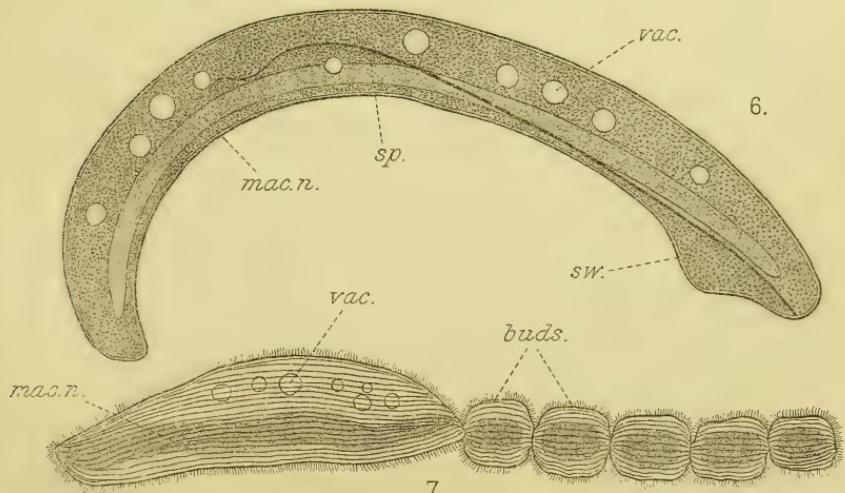
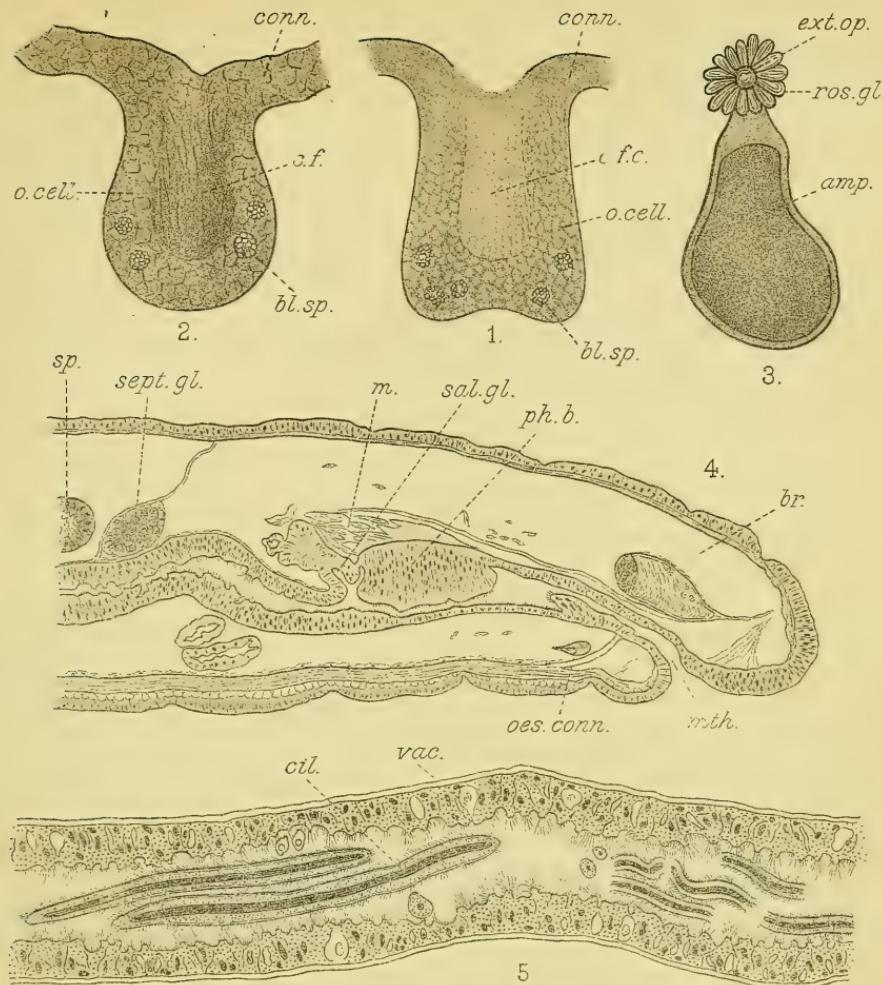
The object of the following paper is to give as full a description as possible of a typical Enchytraeid or "white worm." In spite of the descriptions of Enchytraeids given by Vejdovsky (16), Michaelsen (8, 9, 10), Friend (5, 6), Southern (11, 12, 13), etc., there seems to be need for such a straightforward description, especially of certain points about which much vagueness and difference of opinion exists. The knowledge of our British Enchytraeids is increasing rapidly every year, chiefly owing to Southern in Ireland and Friend in England, but almost all recent work in connection with Enchytraeids has been purely systematic, species new to the British Isles and also new to science being discovered quite frequently.

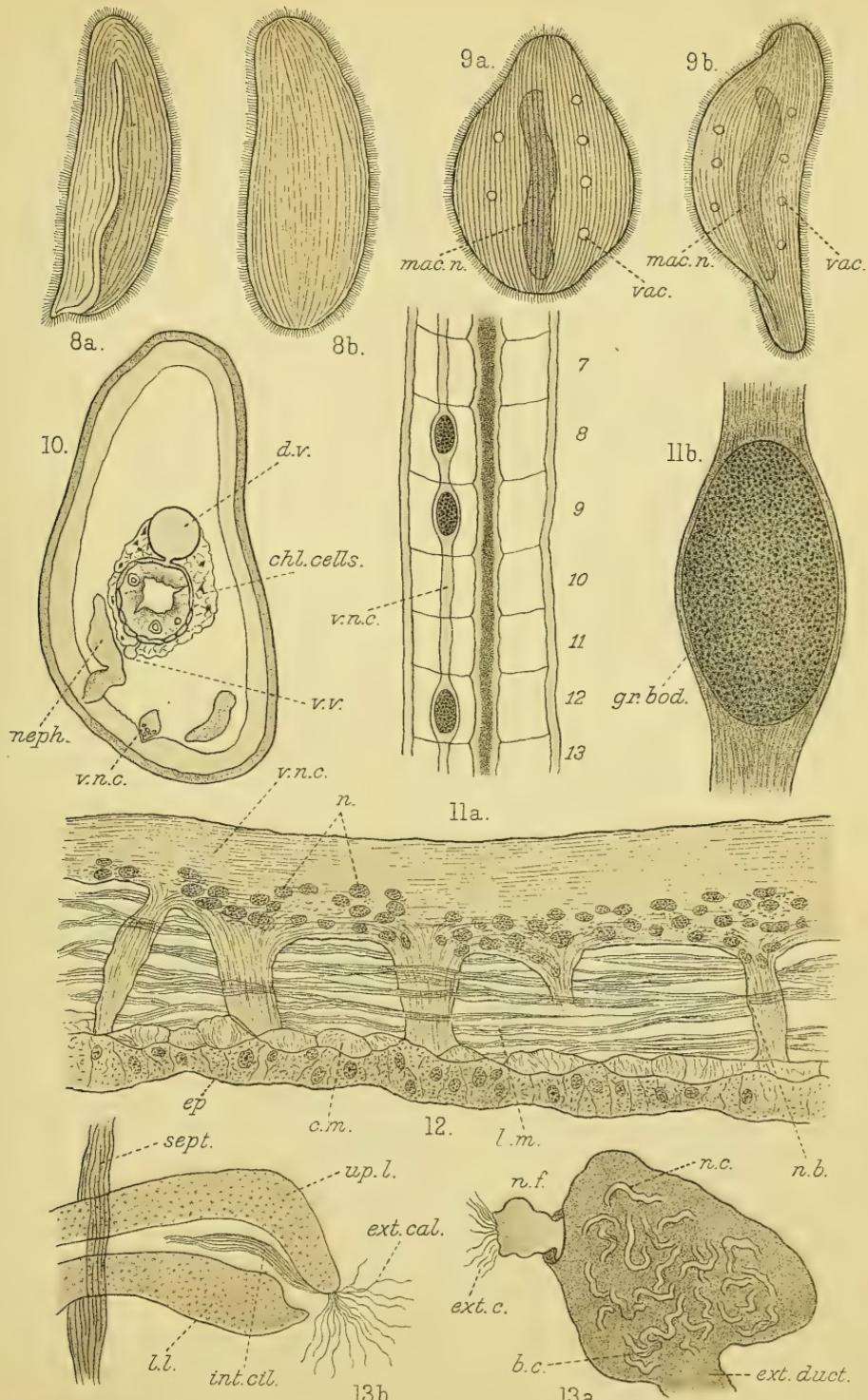
* Festschr. für C. Gegenbaur, Part I. 1896, p. 295.

† Trans. Zool. Soc. London, vol. xvi. pt. vii. p. 329.

‡ Communicated by Prof. F. W. GAMBLE, F.R.S., F.Z.S.

§ For explanation of the Plates see pp. 320-321.

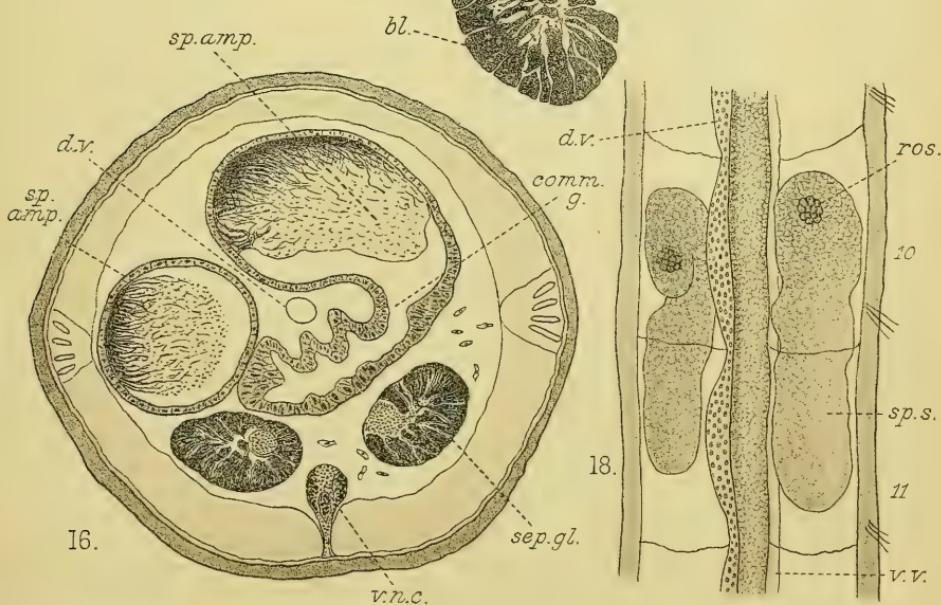
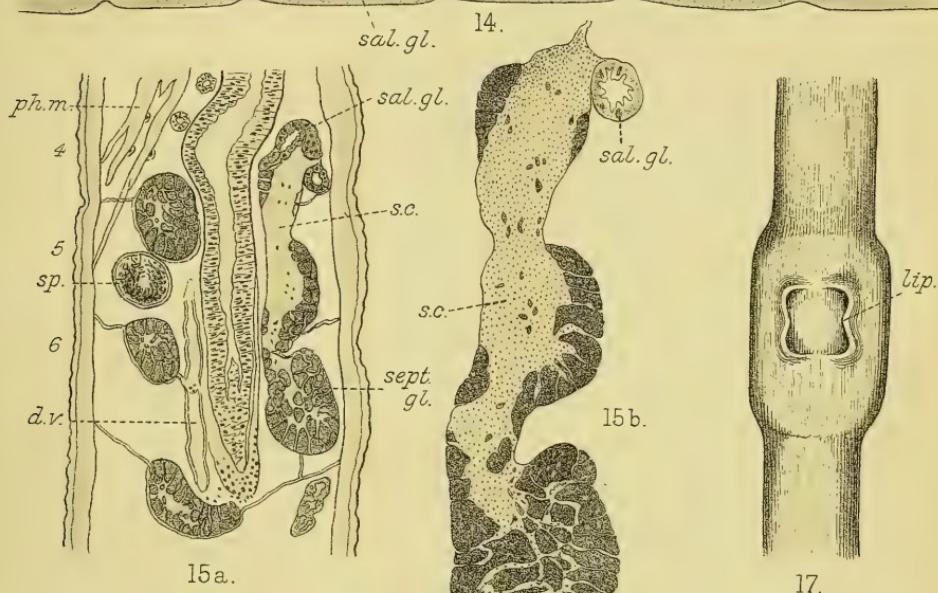
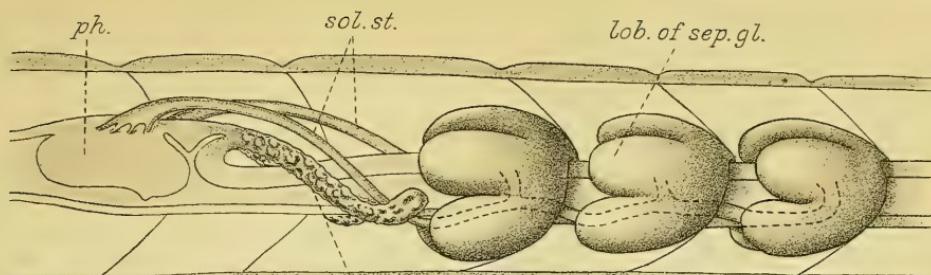


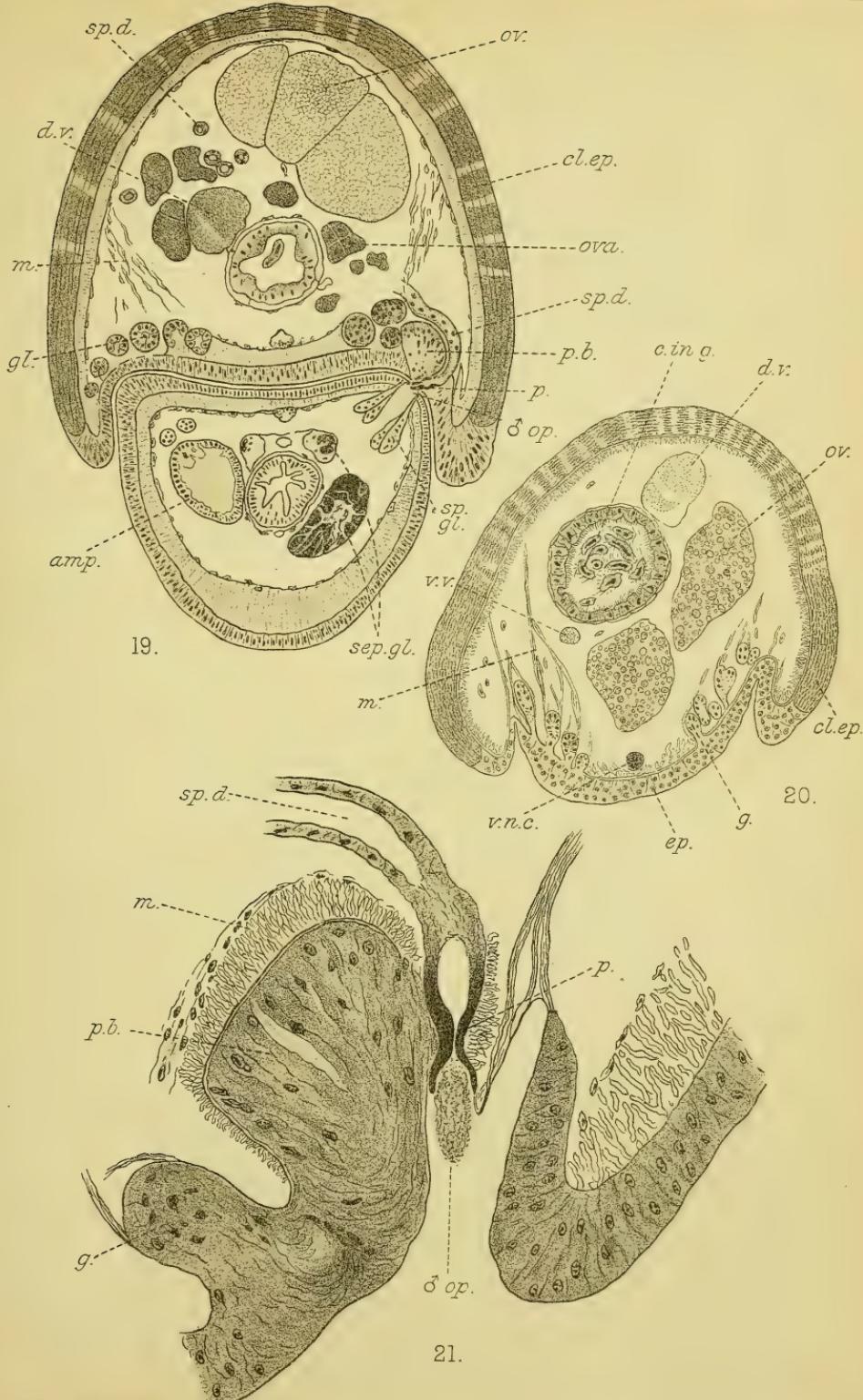


H.H.S. del.ad nat.

West, Newman lith.

ANATOMY AND PROTOZOAL PARASITE OF ENCHYTRÆID WORMS.





Goodrich (7) gives a good description of the nephridia and coelomic corpuscles of a species of *Enchytraeus*, but says very little about any other organs.

The Enchytraeids are amphibious in their habits. They may be found in comparatively dry places, as in soil or leaf-mould; but they are also found in certain places where they are practically living an aquatic mode of life. A common resort of these Enchytraeids is on the sea-shore, but when found here they are most abundant at the point where fresh water is running into the sea. Consequently, they are not purely land or aquatic animals, nor yet are they purely fresh-water or marine.

The Enchytraeids or "white worms" have been found in recent years to be much more plentiful than was formerly supposed. They are found most abundantly wherever there is decaying vegetable matter, such as in leaf-mould, dead and decaying plants, etc. But they are also found, sometimes in large quantities, at the roots of living plants, and ultimately cause the death of these plants. Hewitt (18) found that an Enchytraeid, viz. *Fridericia bisetosa* Levinsen, was the direct cause of the death of a number of larch seedlings. It became a great pest in the nursery, killing off the seedlings by eating away the living cortical tissue of the main root.

I, also, have found Enchytraeids at the roots of living plants. In this case, the plant attacked was *Antirrhinum* from a garden in Edgbaston, Birmingham. The particular Enchytraeid causing the damage was *Enchytraeus argenteus* Mich. As in the case of the larch seedlings, the Enchytraeids were found at the roots, destroying the living cortical tissue and leaving the central woody cylinder exposed.

On account of this the Enchytraeids are probably of great interest from an agricultural point of view, and this paper is a preliminary attempt to discover the economic significance of these "white worms."

The Enchytraeid I have chosen for this paper is *Enchytraeus pellucidus* Friend (5), chiefly because I have an abundant supply of these worms, but also because I think this species is a good type of the whole genus *Enchytraeus*.

There is a difficulty in determining some species of the Enchytraeidae, since the specific differences are sometimes very small. After having closely examined many specimens of *Enchytraeus pellucidus* and also specimens of *Enchytraeus albidus* Henle, which I was able to obtain in large quantities, I have come to the conclusion that *E. pellucidus* cannot be regarded as a distinct species, but only as a variety of *E. albidus*, and differing only slightly from it. According to Michaelsen (10), thirteen authors have, in eighteen papers, given to this worm, *Enchytraeus albidus*, five generic and twelve specific names, so that it is evidently fairly common and probably varies in different localities.

Two of the chief distinctions between *E. albidus* and

E. pellucidus lie in the structure of the brain and spermathecae. The brain of *E. albidus* is definitely concave behind (Pl. XLVI. fig. 1), whilst that of *E. pellucidus* is rounded or convex behind (fig. 2); but this is a variable character, according to the state of tension of the worm, as I have seen the brain of *E. albidus* quite straight behind with no concavity at all, and also the brain of *E. pellucidus* with slight indications of a concavity behind. The spermatheca of *E. albidus* has a definite rosette of glands around the external opening of the duct (fig. 3), whilst *E. pellucidus* is described as having no such glands. But the duct of the spermatheca of *E. pellucidus* is irregular in outline, and in my sections it is seen that these irregularities are due to simple glands, which are not, however, in the form of a definite rosette as in *E. albidus*. Again, the habitat of these two species is the same, viz. old stable-manure and leaf-mould. In all other respects they are very similar.

Short Description of the most easily observed Characters of E. pellucidus.—It is a white transparent worm, from 15 to 20 mm. in length. The number of segments varies, but is usually about 60. The setæ are straight with the innermost ends slightly curved, giving them the appearance of hockey-sticks; the number of setæ is not absolutely constant, but is usually 4 in each bundle in front and 3 behind the clitellum. The brain is twice as long as broad when stretched to the fullest extent, and convex behind with pigment-spots at the posterior end. The nerve-cord is equally broad throughout. Salivary glands (peptonephridia) are present; they are not branched, but simply tubular and slightly coiled or undulating; the free ends are slightly swollen. Blood colourless; sperm-duct very long, often extends 10 or 12 segments behind the clitellum; it is internally ciliated very strongly along its whole length. Spermathecae in segment 5 (external opening at intersegment 4/5), communicate with alimentary canal; ampulla large, filling up the whole of segment 5; no rosette of glands around the external opening of the duct.

Habitat.—My material of *E. pellucidus* was found abundantly in a heap of refuse which consisted for the most part of leaf-mould. In the heap were autumnal sweepings of leaves, grass cut from the lawn, soil, stones, and occasionally bundles of soaked brown paper. Although single worms were common throughout the whole heap, I often came across large quantities of these Enchytraeids quite unexpectedly. When I did so, these worms always looked bigger and healthier, and a large percentage of them was always mature. I have always been able to get mature worms from this heap, whatever the month of the year; this points to the fact that they may be mature all the year round. In the laboratory I kept the Enchytraeids in tin boxes with the leaf-mould in which they were found. They lived quite well here, but I always found that the number of mature worms

steadily decreased until, in about a month's time, I could not find a single mature worm. This heap of leaf-mould, which was situated in a garden in Edgbaston, Birmingham, has been my chief source of material. In the same heap were also numbers of the "Gilt-tail," *Dendrobæna subrubicunda*; this is interesting, as Friend has also noticed that certain Enchytraeids are often associated with certain of the larger earthworms. A favourite retreat of the Enchytraeids was between 2 or 3 decaying beech-leaves that had been tightly compressed, a handful of such decaying leaves often yielding 40 or 50 worms, many of which were quite mature. But I have also found groups of these worms between sheets of damp compressed paper in the heap, although one would be surprised if they obtained much nourishment from that. They were also fairly abundant on the under side of stones. They were very rarely present in any loose material, but seemed to prefer compressed material. Occasionally I have seen these Enchytraeids boring their way inside blackened decaying leaves between the upper and lower epidermis. They were feeding on the soft tissue of the leaf, as an examination of the contents of the gut showed, and this suggests that Enchytraeids may be quite an important factor in the formation of leaf-mould. These Enchytraeids are also very gregarious in their habits; one often wonders if this is due to the worms collecting together at some point where there is a special advantage, *e. g.* nourishment, or whether it is due in some manner to rapid multiplication, owing perhaps to a similar advantage. I have isolated numbers of specimens with a view to seeing whether Enchytraeids are capable of fission, but so far with a negative result.

ANATOMY.

The Pharynx, which is just behind the buccal cavity and occupies segment 2, is interesting because of a large pharyngeal ingrowth. This is an ingrowth of cells from the dorsal side of the wall of the pharynx. It occupies segments 2 and 3, and is composed of elongated spindle-shaped cells, which run dorso-ventrally. The nuclei of these cells are large, elongated, and distinct (Pl. XLVI. fig. 4). This pharyngeal ingrowth almost obliterates the cavity of the gut, reducing it to a small ventral channel. There is some connection between this ingrowth and the septal glands, but this will be referred to later. In this Enchytraeid there is nothing in the nature of a stylet attached to the pharyngeal ingrowth, which has been described in *Enchytraeus buckholzii* Vejd. (18). This stylet was said to be used for clinging to the roots of plants. The function of the pharyngeal ingrowth is not quite plain, but it may be some kind of sensitive organ, as these Enchytraeids, when irritated, often evert the whole of the pharynx spasmodically, the pharyngeal ingrowth then hanging out like a tongue. The pharynx is extremely muscular, the muscles running obliquely backwards from it to the body-

wall. These are the muscles used when the pharynx is everted and then withdrawn. There is another ingrowth of cells from the ventral side, anterior to the pharyngeal ingrowth, but this is much smaller (fig. 4).

The Oesophagus gradually merges into the intestine; the actual point where oesophagus ends and intestine begins cannot be defined.

The Intestine can be seen quite plainly owing to its darker colour, due partly to the food in it and also to its external covering of cells which contain many oil-globules. It is constantly undergoing peristaltic contractions, the waves running from behind forwards. The intestine is covered over its whole length with chloragogen-cells. When these cells break away from the gut-wall, they are seen to be spherical, and contain numerous oil-globules of various sizes. The cells are about $16\ \mu$ in diameter. The intestine is internally strongly ciliated. Owing to the chloragogen-cells which cover the gut, I have never been able to see whether the ciliary current in the intestine begins at the anus and runs forward, or whether it runs backwards to the anus. Stephenson (17) has recently published some interesting considerations on the phenomena of antiperistalsis and ascending ciliary action in the intestine of aquatic Oligochætes. He has never observed ascending ciliary action from behind forwards in the Enchytraeidæ, but thinks that it is very possible that such an action will be found to occur in this group. His reason for this is that "the inhalent function of the intestine is common in the aquatic Oligochæta, and is evidenced by a widely occurring ascending ciliary current in the intestine" (17, p. 74).

The problem of the nutrition of these Enchytraeids is highly important. As already mentioned, I have seen Enchytraeids situated *inside* decaying leaves and literally eating their way through the soft tissue of the leaf. When the contents of the gut is examined, it is found to consist chiefly of disorganized vegetable cells. These are usually brown and dead, but I recently examined the contents of the gut of an Enchytraeid which had been feeding on the green living cells of a plant. In this case the contents of the gut was green in colour, and a greenish fluid was also slowly oozing out from the anus whilst the worm was under pressure. Green vegetable cells could be recognized, although they were being gradually disorganized. These were the soft parenchymatous cells of the leaf or stem. In contrast with these cells, the long vessels and tracheides of the vascular bundles were always extruded quite whole and apparently little changed. This would be due, no doubt, to their thick walls resisting the action of the digestive juices.

The epithelial cells of the gut are strongly ciliated (Pl. XLVI, figs. 4, 5). The nuclei of these cells stain deeply, and there are present numerous large vacuoles or spaces, which often contain masses of material; this material has no affinity for any stains, but is almost colourless. They suggest to me that nutrition may

take place, at least partly, by actual ingestion as well as by diffusion of liquid nutriment. To try to prove this I have made numerous experiments, but they were all unsuccessful. I kept worms alive for a time in a weak solution of methylene-blue, and then examined the cells of the gut to see if any of the solid indigestible particles had been ingested by the cells, but this was unsuccessful. I also tried feeding them on the scum from a hay infusion, which contained numerous cysts, but this was again unsuccessful. If the almost colourless material inside the vacuoles is not actually ingested from the gut, I can only think that it is some digestive liquid, formed by the epithelial lining of the gut in these vacuoles, and then gradually forced into the gut-cavity. This would mean that the vacuoles would be in the nature of small digestive glands. Still, the fact that the cells of the gut are so strongly ciliated, and the presence of these large spaces in the wall of the gut filled with masses of almost colourless material, point at least to the possibility of nutrition being partly by ingestion.

Salivary Glands.—The salivary glands extend as far back as the first pair of septal glands, which are situated in segment 4. They enter the oesophagus just behind the pharyngeal ingrowth (fig. 4). They are paired structures, each being a simple, undulating, tubular gland. Transverse sections show that each gland is of almost uniform thickness, ending in a slight swelling or ampulla. Although these two simple tubular glands converge towards the same point just behind the pharynx, they open into the oesophagus quite separately on the dorsal side.

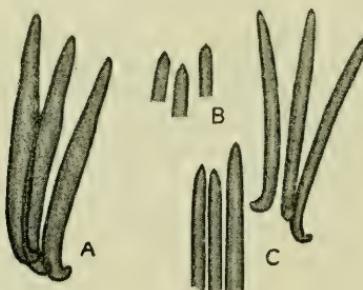
The salivary glands have been called “*peptonephridia*.” The main characters which distinguish these glands from nephridia are (1) there is no opening to the coelom, (2) there is no trace of a funnel, (3) the tubes are not ciliated, and in no Oligo-chætes are there nephridia which are entirely without cilia. On the other hand, the segments occupied by the salivary glands are devoid of other nephridia; and Beddard (1, p. 47) found that in *Octochætus multiporus*, the study of the development revealed the fact that the “salivary glands” were undoubtedly formed by the fusion of at least two pairs of nephridia, which were at first distinct and each provided with its own coelomic funnel which is subsequently lost. This suggests that it is quite possible that in the earlier stages of the development of Enchytraëids, the “salivary glands” might have had an opening into the coelom, and if so, this would do away with one of the chief arguments against the nephridial nature of these “salivary glands.” On the whole, however, it seems best to leave the nephridial or non-nephridial nature of the “salivary glands” an open question.

Setæ.—As before mentioned, the setæ are straight with the innermost ends curved like a hockey-stick. The setæ are slightly swollen in the middle (text-fig. 61 A). New bundles of setæ are constantly being formed by the side of the old ones. Text-fig. 61 B shows three setæ just beginning to be formed, and

text-fig. 61 C shows three setæ almost formed with the three old setæ close beside them.

Blood-system.—The intestine is surrounded by a blood-sinus which is in very close contact with the epithelial lining of the gut. In segment 15 the dorsal portion of this blood-sinus becomes swollen and is gradually pinched off to form a large dorsal vessel. The fact that this dorsal vessel is postclitellar in origin is an important generic character distinguishing the genus *Enchytræus* from most of the other genera in the family Enchytræidæ. This dorsal vessel is continued forward until it reaches segment 1. It then divides into two, each branch going backwards to the ventral side and uniting to form the ventral vessel. This ventral vessel continues, just ventral to the gut, to the posterior end of the worm. Both dorsal and ventral vessels are

Text-fig. 61.



Enchytræus pellucidus.

- A. Three setæ.
- B. Three new setæ just being formed.
- C. Three setæ almost formed with the three old setæ close to them.

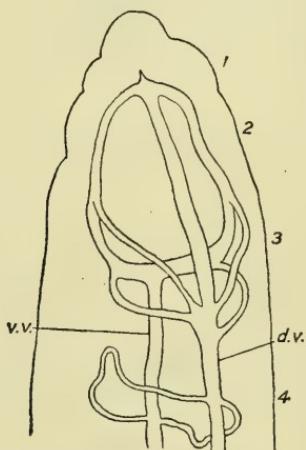
joined at intervals to the gut-sinus by small vessels (Pl. XLVII. fig. 10). There are three pairs of lateral vessels also in the anterior blood-system; two pairs are given off close together and join the two branches which form the ventral vessel, and one pair is given off just behind this and joins the ventral vessel proper. Text-fig. 62 represents this anterior blood-system.

The dorsal vessel, which is very large at its point of origin, is partly covered with chloragogen-cells, which also extend round the gut. At the point where the dorsal vessel arises, it swells and contracts rhythmically, sending the blood forward. I have seen no trace of the cardiac body, "a solid rod of cells attached to the ventral side of the dorsal blood-vessel, and extending along its whole length" (1, pp. 77-78), in *Enchytræus pellucidus*. This cardiac body was first described by Michaelsen in the genus *Mesenchytræus*. He suggested that this solid rod of cells served to ease the contractions of the dorsal vessel. The blood is a colourless fluid with no blood-corpuscles.

Nervous System.—The brain is dorsal in segment 1. Anteriorly it gives off two connectives which unite ventrally to form the ventral nerve-cord. The connectives can be traced in sections; they are in close approximation with the body-wall of the 1st segment and seem to be connected at this point with a ring of tissue which appears to be nervous. It may be this nervous ring of tissue which makes the 1st segment, including the prostomium, so extremely sensitive.

The brain is twice as long as broad when stretched to its fullest extent, and oval in shape. Posteriorly it is rounded, but occasionally shows signs of a concavity. The brain itself seems to be composed of two parts, a central core and an outer portion (Pl. XLVI. figs. 1 & 2). The outer portion is cellular in structure;

Text-fig. 62.



Anterior blood-system of *Enchytraeus pellucidus*.

d.v., dorsal vessel; *v.v.*, ventral vessel.

the cells are small and numerous, and each one has a prominent nucleus. In preparations, the outer portion stains very deeply owing to the large number of nuclei. The central core is fibrous in structure with no nuclei showing.

Pigment-spots in the Brain.—At the posterior end of the brain there are numerous black spots in the outer cellular portion (fig. 2). These vary in number, usually 4 to 8, and are not regularly or symmetrically placed. Although these bodies have been mentioned by some authors, I have never seen them fully described, nor have I seen any suggestions as to their possible function. If the brain be carefully dissected out and examined under the high power of a microscope, the pigment-spots seem to be dark, granular or oily, with a clear spot in the centre. They are always present in this worm. Each black spot is composed

of a number of small, rounded, highly refractive bodies. From their appearance one would almost think they were ocelli of some kind. However, their function is, I believe, unknown, and more work is required upon them before they could definitely be called ocelli.

In *E. pellucidus* there is nothing in the nature of winged expansions to the nerve-cord, which have been described in some Enchytraëids (6). The so-called "copulation-glands," which is the name given to masses of large cells which almost surround the nerve-cord in segments 13 and 14 (14), are not present in *Enchytraeus pellucidus*.

The ventral nerve-cord sends out numerous branches to the body-wall. Fig. 12 (Pl. XLVII.) shows a longitudinal section of the body-wall passing through the nerve-cord. Here the nerve-branches are very thick strands and can be seen passing through the longitudinal muscles to the epidermis.

The nuclei of the nerve-cord are always situated in the ventral region only; the rest of the nerve-cord is fibrous in structure and has no nuclei.

In transverse sections, one almost invariably sees a number of clear spaces, usually two or three, in the nerve-cord. These have every appearance of being giant fibres running longitudinally along the cord.

It would be as well to describe here some curious bodies in the nerve-cord, which I have only seen twice in the large number of Enchytraëids I have examined. I saw them first in a small immature Enchytraeid in each of segments 8, 9, and 12. Just recently I have again seen an exactly similar body in a fully mature specimen of *E. pellucidus*; in this case it appeared in segment 14. Under the high power they appeared to be very granular, definite, oval bodies, quite distinct from the nerve-cord itself, but embedded in it (Pl. XLVII. fig. 11 a, b). I have seen no description of these bodies elsewhere, and am inclined to think that they were of a parasitic nature, but since I have only seen them twice, I have been unable to do more than describe them.

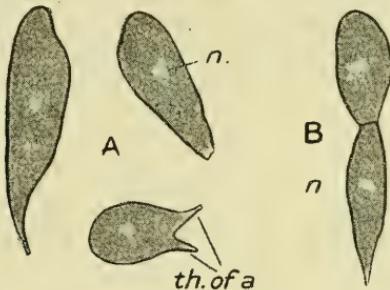
Cœlomic Corpuscles.—The cœlomic corpuscles in *E. pellucidus* are comparatively few in number. In some Enchytraëids they are so numerous that it is very difficult to examine the various organs in the living worm; but *E. pellucidus* is so transparent that the nephridia, brain, etc., can be seen quite easily.

My observations on the cœlomic corpuscles agree very closely with those of Goodrich in his description of *E. hortensis* (7).

(a) By far the commonest and largest type of corpuscle is oval in shape and flattened (text-fig. 63 A). It varies from $47\ \mu$ to $23\ \mu$ in length and from $12\ \mu$ to $8\ \mu$ in breadth. It is very granular, with a clearer spot in the centre, the nucleus. It is usually rounded at one end and at the other end drawn out into one or two threads, the points of attachment to the cœlomic epithelium. Whilst examining the living worm, one can always see a number of these corpuscles attached to the walls of the

cœlomic cavity and the free ends moving about with the flow of the cœlomic fluid. The pressure of the cover-slip on the worm is all that is necessary to obtain these corpuscles, which are forced out through the *head-pore* to relieve the pressure. The head-pore is situated between the prostomium and the 1st segment in the dorsal median line. Very often, also, the cœlomic contents are

Text-fig. 63.



A. Cœlomic corpuscles of *Enchytraeus pellucidus*.

B. Corpuscle just dividing into two.

n., nucleus; *th. of a.*, threads of attachment to the cœlomic wall.

forced out through a pore near the anus. The presence of this pore near the anus is not so generally known as that of the head-pore, but it is certainly there, although rather difficult to see. Goodrich (7) has never seen any cases of multiplication by division of these corpuscles, but I have often observed these corpuscles in various stages of division (text-fig. 63 B).

(b) The second type of cœlomic corpuscle (text-fig. 64) is

Text-fig. 64.



Three stages in the disintegration of a cœlomic corpuscle of *Enchytraeus pellucidus*.

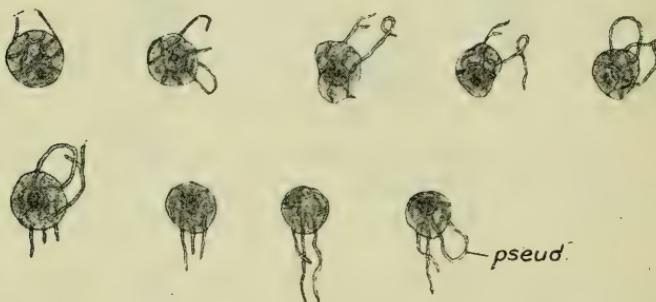
Ref.bod., refringent body; *coil.th.*, coiled thread; *n.*, nucleus.

smaller and not uniformly granular, but certainly seems, as Goodrich suggests, to be a variety of the first kind of corpuscle. In it there is a colourless and very refringent body, whilst the rest of the corpuscle is granular. The curious fact is that when

this corpuscle comes into contact with a strange fluid, such as distilled water, the colourless body swells and begins to show that it is really formed of a long thread of transparent substance. This long thread is very much coiled, and as it swells out the rest of the cell disintegrates. Text-fig. 64 shows three stages in the disintegration of one of these corpuscles. Salt solution is much the best medium in which to examine the coelomic corpuscles, as they disappear very rapidly when put into distilled water.

(c) The third type of corpuscle is the *ameboid corpuscle*. This is a small, almost spherical corpuscle, with a number of clear pseudopodia. Text-fig. 65 shows a number of drawings of the same amœboid corpuscle taken at intervals of about half a minute.

Text-fig. 65.



Drawings of the same amœboid corpuscle of *Enchytraeus pellucidus* taken at intervals of half a minute.

Pseud., pseudopodia.

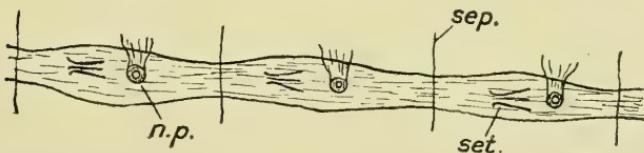
In the living worm one often sees the free coelomic contents moving apparently through the septa from segment to segment. I often wondered whether there were any *definite* apertures in the septa through which these corpuscles could travel, and, if so, where they were. In transverse sections, I happened to get a section through a septum which showed quite plainly that there were at least two definite holes in the septum. These were situated dorso-laterally and were semicircular in shape. They were large and distinct, and the coelomic corpuscles were especially crowded round the edges of the septum adjoining the hole.

Nephridia.—Goodrich (7) has given a full account of these organs in *E. hortensis*, a species closely allied to, if not identical with, *E. albidus*, and I have been able to confirm his excellent description in most particulars.

There are no nephridia in the first six segments, the first nephridium occurring in segment 7. The nephridium is a lobed flattened body (Pl. XLVII. fig. 13 a). It is composed of three parts, an anteseptal portion, the flattened body of the nephridium,

and the duct leading to the exterior. The anteseptal portion is small and consists of the funnel (fig. 13 *b*). This funnel is composed of two lips. From the extremity of the upper lip are given off numerous very fine cilia, which wave about independently in the body-cavity. From the inner surface of the upper lip there also arises a number of long cilia, but unlike the external cilia these move simultaneously and rhythmically, forming an undulating bunch. The function of this bunch of undulating cilia is undoubtedly to propel liquid down the canal which leads from the funnel. The flattened body of the nephridium consists of granular cells, through which runs the nephridial canal. At numerous points (usually about 4 or 5), but not continuously through this canal, one can see bunches or "flames" of cilia similar to the bunch in the funnel. All this ciliary action can be observed in the living worm. The duct leading to the exterior is broad, and is given off from the posterior end of the body of the nephridium. The nephridiopores are arranged definitely on a band of tissue running longitudinally along each ventro-lateral surface, and the nephridiopore is always situated on this band just anterior to the setæ of each segment (text-fig. 66).

Text-fig. 66.



Drawing to show the position of the nephridiopores in *Enchytraeus pellucidus*.

sep., septum; *set.*, setæ (ventral); *n.p.*, nephridiopore.

Septal Glands.—The septal glands are organs of unknown function situated in segments 4, 5, and 6, and attached to the posterior septum of each of these segments. They are always present, both in quite young Enchytraeids and in old mature ones. In the living worm they appear as lobed organs surrounding the gut. Each gland consists of four lobes, which project forwards and surround the gut, being united on the dorsal side but not on the ventral. Fig. 14 (Pl. XLVIII.) shows a semi-diagrammatic drawing of these organs *in situ*, which has been obtained by reconstruction from a series of transverse and longitudinal sections. The septal glands are solid organs with no central cavity. I have examined numerous series of transverse sections, but have never been able to discover any opening into the gut. The gland itself (Pl. XLVIII. fig. 15 *a & b*) consists of two parts; one part, which comprises the bulk of the gland, is composed of solid blocks of tissue. These are remarkable for the readiness with which they take up stains such as Hæmalum,

Haematoxylin, etc. The other part is in the nature of a connecting-link, and might be called the "core" of the septal glands. It consists of two solid nucleated strands, one on each side of the gut, which only stain slightly and connect together all the septal glands. Now, if these connecting-strands were hollow or tubular, one could easily understand that the septal glands were, in reality, glands, and that the connecting-strand was a duct to carry off their secretions. But the connecting-strands are solid, and appear quite incapable of carrying any liquid secretion. I have also been struck by the resemblance which these connecting-strands bear to nervous cords or strands, but in tracing them through series of sections I have been unable to find any connection with the main nervous system.

In segment 4, these solid strands leave the substance of the first septal gland and travel forwards parallel and close to the salivary glands. They then move towards the dorsal side and finally enter the substance of the large pharyngeal ingrowth on the dorsal side, first dividing into four or five branches (fig. 14).

Significance of Septal Glands.—Owing to the lack of observation upon the development of these organs there is considerable doubt as to their morphology, and still more as to their function. Beddard (1), quoting Vejdovsky, shows that they are of widespread occurrence in Oligochaetes. They even occur in the early stages of Lumbricidae, but disappear in the course of development. Up to the present time these glands have been regarded as single and not compound structures. The above description shows that they contain two distinct anatomical components.

The strands connecting the septal glands with the pharynx are not muscular, and therefore it seems as if they are not merely supporting strands. Neither are they ducts, and therefore, if the septal glands have a glandular function, one wonders how this internal secretion is transmitted to its destination. I am inclined to the view that the connecting solid strands are nervous, and if some connection with the central nervous system could be found, it would make the problem of solving what these organs are, considerably easier. If the connecting-strand is an epithelial structure, it is quite possible that it may originate as an outgrowth from the pharynx (*cf.* Outgrowths in Capitellids of Eisig), but even this will not explain the "core," which has such a delicate fibrillar structure. Nor can a simple septal origin be accepted, since in that case it would be difficult to understand the "gland" opening into the pharynx.

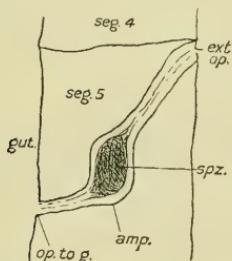
Reproductive Organs.—All existing accounts of the reproductive organs of Enchytraeids are vague and incomplete. Certain of the reproductive organs are well understood; *e. g.* the male efferent apparatus consisting of the sperm-funnel and sperm-duct; but, on the other hand, the question of the female opening, the oviducts (if present), and the problem as to how such large ova as are found in Enchytraeids escape by such insignificant female pores, are still unsolved.

According to Michaelsen (9), "The reproductive apparatus of Enchytraëids varies very little. The testes are formed on the posterior side of the septum between segments 10 and 11, and the ovaries on dissepiment 11/12. Two sperm-funnels are present in segment 11. The sperm-ducts lead from the sperm-funnels, and each opens in a penis-like swelling on the ventral side of segment 12. A pair of oviducts open on the ventral side of segment 13. The spermathecae lie in segment 5 and open externally on the intersegmental furrow, segments 4/5. The clitellum covers segment 12 and often parts of segments 11 and 13."

Spermathecae.—In *Enchytraeus pellucidus* the spermathecae are present in segment 5. In the fully mature worm they are large organs, filling up practically the whole of the body-cavity in that segment. They open at intersegment 4/5.

The ampulla of the spermatheca is large and pear-shaped, with the narrow end anterior. In a mature worm, after copulation has taken place, the spermatozoa can be seen through the walls of the ampulla, giving it a definite golden-brown colour. The duct leading to the exterior is not so long as the ampulla, and in *E. pellucidus* has not got a definite rosette of glands around the external opening. Fig. 3 (Pl. XLVI.) shows the spermatheca of *E. albidus*, with the rosette of glands round the external aperture—it had been dissected away from the worm, and therefore the connection with the gut is not seen. To show how this spermatheca differs from the spermatheca in other species, I give a figure of the spermatheca of a mature specimen of *Enchytraeus argenteus*. In this worm the ampulla of the spermatheca is merely a slight swelling of the spermathecal tube.

Text-fig. 67.



Spermatheca of *Enchytraeus argenteus*, for comparison with fig. 3 (Pl. XLVI.).

spz., sperms in the ampulla; *amp.*, ampulla; *op. to g.*, opening of spermatheca into the gut.

The spermatheca always communicates with the gut (Pl. XLVIII. fig. 16), sometimes by a long connection and sometimes by a short one. In *E. pellucidus* the connection with the gut is short and wide. The fact that the spermatheca communicates

with the gut has been known for some time, but it has never been satisfactorily explained why this is so. My own observations show that spermatozoa are occasionally seen in the tube connecting the ampulla with the gut, but by far the majority are stored in the ampulla with their heads buried in the wall and their tails free in the cavity of the ampulla. In transverse sections, at the point where the spermatheca opens into the gut, I have occasionally seen a number of spermatozoa actually in the gut. Although they were quite near to the spermathecal opening, I think this observation supports the view that this connection between spermatheca and gut has some definite function, probably to allow the excess spermatozoa to escape from the spermatheca.

One can always see where the gut ends and the spermatheca begins, because the epithelial cells of the gut are ciliated, whilst those of the spermatheca are not.

Some time ago I had the good fortune to observe two Enchytraeids in copulation. They were lying quite still, with the ventral surfaces very close together, so that the spermathecal opening in each worm was directly in touch with the male opening of the other worm. They were so tightly fixed together that even whilst killing and fixing them they did not separate, and so I was able to obtain sections through this region. Fig. 17 (Pl. XLVIII.) shows a drawing of the ventral clitellar region. From this it is seen that there is a shallow depression, overhung on each side by a lip. Underneath each lip and in the groove is the male opening. During copulation the fifth segment of one worm fits closely into this shallow depression and is held in position partly by the overhanging lip, but also probably by the secretion of certain glands in this region, to be described later. Fig. 19 (Pl. XLIX.) shows a drawing of a section through these two copulating Enchytraeids. The ampulla of the spermatheca is seen on one side, whilst on the other side is the external opening of the other spermatheca in close approximation with the penis-like termination of the sperm-duct, which is protruding through the male opening.

Sperm-funnels.—The sperm-funnels of *E. pellucidus* occupy the clitellar region. They are very long, sometimes being as much as seven or eight times as long as broad, and are often bent upon themselves. They lie free in the body-cavity. The mouth of the sperm-funnel is large and has a swollen ridge, in which are embedded the heads of numerous spermatozoa. The tails of the spermatozoa hang out stiff and straight like the bristles of a brush, and when viewed in the living worm are of a beautiful golden-brown colour. The sperm-duct leads from the sperm-funnel and is very long and coiled. It is very strongly ciliated internally along the whole of its length. The coils of this sperm-duct are free in the body-cavity and often extend a dozen segments behind the clitellum before finally ending in the male opening on segment 12.

We now come to some gland-like bodies which are present in the clitellar region, and which I have not seen described before (Pl. XLIX. fig. 20). These bodies protrude into the body-cavity in the ventral region of segment 12 on both sides of the male openings. They are continuous with the epidermis, which in the ventral region is composed of true epidermal cells, as the clitellar epithelium does not extend over the ventral region. These bodies are usually solid and composed of a few cells; they are oval in shape and the cells have prominent nuclei. I have occasionally seen signs of slit-like cavities in them, but even then there has been nothing approaching a duct to the exterior. One can see quite clearly that the cells forming these glands are continuous with the epidermal cells, and they have evidently been formed as impittings from the epidermis. The muscular system in this region is also slightly modified. Surrounding these glands are strong muscles, which are continued obliquely across the body-cavity to the lateral wall. These oblique muscles are not found anywhere else, except in the region of these glands. I think the most probable solution of the function of these glands is that they form some kind of secretion which helps to make the worms adhere together closely during copulation.

Male Opening.—The actual male opening is worthy of note. The sperm-duct ends in a peculiar chitinous-like thickening (Pl. XLIX. fig. 21). This penis-like thickening of the sperm-duct opens to the exterior in a groove. It does not pass through the so-called penial bulb, but only skirts the edge of it. The penial bulb (fig. 21) has every appearance of being simply one of these ventral clitellar glands just described, but it is always rather bigger. The cells composing it are continuous with the epidermis, and it has a very strong muscular coat.

Sperm-sacs (*Vesiculae Seminales*).—Beddard, in his ‘Monograph of the Oligochætes,’ says: “In only one family of Oligochætes are the sperm-sacs nearly always absent; this family is the Enchytraeidæ. The genus *Mesenchytræus*, however, has paired sperm-sacs which originate from the septum bounding posteriorly the segment in which the male gonads lie.”

In *E. pellucidus* there are two large sacs filling up almost the whole of the body-cavity in segments 10 and 11. These sacs are filled with sperm mother-cells and masses of spermatozoa in various stages of development. Since ‘sperm-sacs’ is the name given to sacs in which the sperm undergoes most of the stages of its development, then these sacs in *E. pellucidus* are undoubtedly sperm-sacs, and not testes. As to the true testes, I cannot say that I have ever seen them, but the following may have some reference to them.

In certain Enchytraeidæ which are not quite sexually mature, *i. e.* when the ovaries and sperm-funnels are small, I have noticed a peculiar rosette of small cells in the anterior end of each sperm-sac. This mass of cells, when seen in the living animal, is of a definite golden-brown colour (Pl. XLVIII. fig. 18).

Ovaries and Oviducts.—The ovaries are situated in segment 12. In the mature worm the ova are so large that they almost fill up the whole of the body-cavity in that region, and are of a pure white colour. When ripe, they break away from the ovary and lie apparently quite freely in the body-cavity.

In the lower Oligochaetes there are no special ducts for the ova, e. g. *Aelosoma* simply has a median pore. Beddard (1) says that "the structure of the oviducts in Enchytraeids is such as to suggest a degenerate condition." D'Udekem's opinion was that the sperm-ducts served as ducts for the ova also. Later it was suggested that there might simply be pores in the body-wall through which the ova might escape to the exterior. For some time these pores could not be found, but Claparède (4) at last described a pair of pores behind the male pores in *Enchytraeus vermicularis*, and these were afterwards verified by Vejdovsky and Michaelsen. However, both Vejdovsky and Michaelsen regarded them as mere pores for the escape of the ova without any trace of oviducts. Beddard (2) has described the oviducts in *Pachydrilus* (Enchytraeidæ). They consist of a few pear-shaped cells, not ciliated, which fringe the orifices. He regards them as degenerate oviducts.

My own observations on *E. pellucidus* show that there is certainly a pair of these pores in the body-wall in segment 13. But, instead of a few non-ciliated cells fringing these openings, it is quite plain that these two pores communicate with a single, large, thin-walled sac, which fills up almost the whole of the body-cavity in this region. Since the mature ova in this Enchytraeid are large, then either the ova are capable of altering their shape with ease or else these pores are capable of great distension. The former seems to be most likely, as there are no extra muscles connected with these female pores.

APPENDIX.

Astomatous Ciliate Protozoa in the Gut.

Whilst working at the alimentary canal of this worm, I was surprised to come across numbers of large ciliates living commensally in the gut. They were usually found in the middle region, and not at the posterior or anterior ends of the gut. There were often so many of them present that they almost filled the cavity of the intestine. Many of these ciliates showed signs of budding; it was quite a common occurrence to come across a ciliate with anything from one to six buds at the hinder end, and the pressure of the cover-slip was only required to make one or two of the buds break off and swim about independently.

The largest and commonest of these ciliates living in the gut was *Mesnilella fastigiata* (3). The length of this ciliate varies considerably, but an average length is .3 to .4 mm. It is elongated and cylindrical in shape, with a

curious swelling at the anterior end on one side. The most characteristic feature is a strong chitinous-like spicule running from one end through the body of the ciliate, and ending at about two-thirds the length of the body in a fine curled thread, almost like the lash of a whip (Pl. XLVI. fig. 6). The protoplasm is granular, and there are parallel ridges running along the whole length of the body, on which rows of cilia are constantly in motion. The macronucleus is very long, extending the whole length of the body, and there are numerous vacuoles present. The micronucleus could not be seen in my own preparations, and is, I believe, unknown. Fig. 5 shows a longitudinal section through the gut, in which a number of these ciliates is present.

Less frequently I have found three other ciliates in the gut. The first is shown in fig. 7. It is somewhat similar to *Mesnilella*, although not usually so large. It is chiefly distinguished from *Mesnilella* by the absence of the spicule. The ciliate shown in fig. 7 had five buds attached.

The next ciliate was much smaller, and I have never seen any signs of it budding. Its shape is difficult to describe, and can be best realized from two drawings illustrating the ciliate turning round on its short axis (Pl. XLVII. figs. 8 a & 8 b). It measured 90 μ by 30 μ . This ciliate was also without a spicule.

The last ciliate I observed was again much smaller than *Mesnilella* and of a peculiar shape. It is best described as hat-shaped (figs. 9 a & 9 b). The macronucleus was long and slightly curved. Vacuoles were present, and were situated in two longitudinal rows. I have not been able to discover any description of the three last-mentioned ciliates.

Summary of New and Confirmatory Observations.

(1) *New Observations.*

(a) *The Presence and Structure of the peculiar Black Spots at the Posterior End of the Brain.*—These spots were not arranged definitely, but were scattered about in the outer cellular portion of the brain. When the brain was dissected out and examined under a high power ($\times 1000$), each of the spots was seen to be composed of a number of small, spherical, oil-like globules. Although at first I thought these bodies were very similar to ocelli, I have come to the conclusion that they are probably of the nature of very minute oil-globules. The reason for this is that they cannot be seen in any of my preparations or sections which have been treated with xylol or cedar-wood oil. However, the true meaning of these black spots in the brain is by no means clear as yet.

(b) *The Structure and Significance of the so-called "Septal Glands."*—Hitherto these glands have been regarded as single and not compound structures. The description given shows that they contain two definite anatomical components. The meaning of the connection of the septal glands with the pharynx is not

understood, and makes the question of the origin of the septal glands much more complicated. The structure of the strands connecting the septal glands with the pharynx leads one to try and discover whether these strands are connected in some manner with the nervous system, but my own observations prove most conclusively that they end blindly in the substance of the pharyngeal bulb.

The diagram of the septal glands (Pl. XLVIII. fig. 14), reconstructed from series of transverse and longitudinal sections, is useful in enabling one to understand the exact shape of these glands and also their relation with the gut and the solid strands connecting the glands. Most existing drawings of the septal glands are sketches taken from the living animal, and, although these give one a rough idea of their shape, they are never very satisfactory.

(c) *Presence of a thin-walled Ovisac which communicates with the Exterior by two Pores in Segment 13.*—Although in my preparations ova have not been actually seen in this thin-walled sac, there can be little doubt but that it is an ovisac. The fact that it communicates with the female pores on segment 13 proves that ova must, at some time, be present in the sac in order to escape to the exterior by the female pores.

(d) *The ventral clitellar Glands.*—It seems likely that the function of these glands is to secrete a substance which will enable two copulating Enchytraeids to be held firmly together. My own observations on two copulating Enchytraeids show that there is certainly something which enables the two worms to adhere very closely together.

It is difficult to account for the extraordinary muscles which cover these glands and extend obliquely across to the body-wall.

According to anatomical evidence, the "penial bulb" is simply an enlarged ventral clitellar gland. It is epidermal in origin like the ventral glands near it, and has a similar but slightly thicker muscular coat.

These ventral clitellar glands (although it is quite likely that they are "copulation-glands") must not be confused with the masses of large cells which almost surround the nerve-cord in some Enchytraeids (segments 13 and 14), and which have also been called "copulation-glands."

(e) *Astomatous Ciliate Protozoa in the Gut of Enchytraeids.*—Altogether four different kinds of these ciliates have been found in the gut of *E. pellucidus*. The commonest and largest of them was *Mesnilella*; this was also the only one which had the chitinous-like rod or spicule. This ciliate has already been recorded and described by Cépède in his extremely useful work on the Astomatous Infusorians (3), but I have not been able to find any records or descriptions of the other three ciliates, so that they may be quite new.

(f) *Observations on two Copulating Enchytraeids.*—These observations on two Enchytraeids in copulation are interesting, as one

rarely sees such convincing evidence as a transverse section passing through the male opening of one Enchytraeid and the spermathecal opening of the other. The Enchytraeids were evidently killed and fixed just after the sperms had been actually transferred to the spermathecae by means of the sperm-ducts.

(2). *Confirmatory Observations.*

After a fairly exhaustive examination of the nephridia and coelomic corpuscles, I have been able to confirm the excellent observations of Goodrich (7) in most particulars.

In conclusion, I must thank the Birmingham Natural History Society for helping me in this work by means of a grant from the Endowment of Research Fund, and I should also like to express my deep indebtedness to Professor Gamble for his kindly help and most valuable criticism.

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EXPLANATION OF THE PLATES.

PLATE XLVI.

- Fig.
1. Brain of *Enchytraeus albidus* Henle.
 2. Brain of *Enchytraeus pellucidus* Friend. *cf.*, central fibrous portion; *o.cell.*, outer cellular portion; *conn.*, esophageal nerve-connectives; *bl.sp.*, black spots on brain.
 3. Spermatheca of *Enchytraeus albidus*, dissected from the worm. *ext.op.*, external opening; *ros.gl.*, rosette of glands; *amp.*, ampulla.
 4. Longitudinal sagittal section of *E. pellucidus* through the first four segments. *ph.b.*, pharyngeal bulb or ingrowth; *br.*, brain; *sal.gl.*, salivary gland opening into pharynx; *m.*, muscles attached to pharynx; *sept.gl.*, septal glands; *sp.*, spermatheca; *aes.conn.*, esophageal nerve-connective; *mth.*, mouth.
 5. Longitudinal section of the gut, to show ciliates in the gut and structure of gut-wall. *cil.*, ciliates in gut; *vac.*, vacuoles between the cells, sometimes containing a colourless mass.
 6. *Mesnilella fastigiata*, found in the gut of *E. pellucidus*. *mac.n.*, macronucleus; *sp.*, spicule; *vac.*, vacuole; *sw.*, characteristic swelling at one end.
 7. Ciliate with five buds, found in the gut. *mac.n.*, macronucleus; *vac.*, vacuoles.

PLATE XLVII.

- Fig.
8. Two views (*a*) and (*b*) of another ciliate from the gut.
 9. Two views (*a*) and (*b*) of a fourth ciliate from the gut. *mac.n.*, macronucleus; *vac.*, vacuoles arranged in two longitudinal rows.
 10. Transverse section to show the small blood-vessels connecting dorsal and ventral vessels with the blood-sinus surrounding the gut. *d.v.*, dorsal vessel; *v.v.*, ventral vessel; *chl.cells*, chloragogen-cells surrounding the gut; *neph.*, nephridium; *v.n.c.*, ventral nerve-cord.
 11. (*a*) Diagram of segments 8–12, to show peculiar bodies in the nerve-cord. (*b*) Nerve-cord, with one of these bodies embedded in it (much higher power). *v.n.c.*, ventral nerve-cord; *gr.bod.*, granular bodies in the nerve-cord.
 12. Longitudinal section through nerve-cord and ventral body-wall. *ep.*, epidermis; *c.m.*, circular muscles; *l.m.*, longitudinal muscles; *n.b.*, nerve-branch; *v.n.c.*, ventral nerve-cord; *n.*, nuclei.
 13. (*a*) Nephridium. (*b*) Nephridial funnel. *n.f.*, nephridial funnel; *ext.e.*, external cilia; *n.c.*, nephridial canal; *b.c.*, bunch of cilia; *ext.duct.*, duct to the exterior; *sept.*, septum; *up.l.*, upper lip; *l.l.*, lower lip; *int.cil.*, internal bunch of cilia; *ext.cil.*, external independent cilia.

PLATE XLVIII.

- Fig.
14. Semi-diagrammatic drawing of the septal glands, obtained by reconstruction from sections. *ph.*, pharynx; *sal.gl.*, salivary glands; *lob. of sep.gl.*, lobe of the septal gland in segment 5; *sol.st.*, solid strands connecting septal glands with pharynx.
 15. (*a*) Longitudinal sagittal section through segments 4–6, showing septal glands: *sp.*, spermatheca; *ph.m.*, pharyngeal muscles; *d.v.*, dorsal vessel; *sept.gl.*, septal gland in segment 6; *s.c.*, solid cord connecting the three septal glands; *sal.gl.*, salivary glands. (*b*) More magnified view of part of the previous section: *bl.*, solid blocks of tissue; *s.c.*, solid cord connecting the three septal glands.

- Fig. 16. Transverse section through the spermatheca, showing communication with the gut. *sp.amp.*, spermathecal ampulla; *comm.g.*, communication with gut; *d.v.*, dorsal vessel; *sep.gl.*, septal glands; *v.n.c.*, ventral nerve-cord.
17. Drawing of the ventral clitellar region. *lip*, lip overhanging the groove in which the male pore is situated.
18. Diagrammatic drawing of segments 10 and 11 of a young mature Enchytraeid, showing the sperm-sacs. *d.v.*, dorsal vessel; *sp.s.*, sperm-sac; *v.v.*, ventral vessel; *ros.*, rosette of cells in the sperm-sac.

PLATE XLIX.

- Fig. 19. Transverse section through two copulating Enchytraeids. *ov.*, ovary; *cl.ep.*, clitellar epithelium; *sp.d.*, sperm-duct; *p.b.*, penial bulb; *p.*, penis; *op.*, male opening; *sp.gl.*, spermathecal glands; *sep.gl.*, septal glands; *amp.*, ampulla of spermatheca; *gl.*, glands in the ventral clitellar region; *m.*, muscles attached to these clitellar glands and the body-wall; *d.v.*, dorsal vessel.
20. Transverse section through segment 12 to show gland-like bodies in the ventral clitellar region. *d.v.*, dorsal vessel; *ov.*, ovary; *cl.ep.*, clitellar epithelium; *g.*, gland-like bodies continuous with the epidermis; *ep.*, epidermis; *v.n.c.*, ventral nerve-cord; *m.*, muscles connecting gland-like bodies obliquely with the body-wall; *v.v.*, ventral vessel; *c. in g.*, ciliae in gut.
21. Highly magnified section through the male opening. *sp.d.*, sperm-duct; *p.*, penis-like thickening; *op.*, male opening; *p.b.*, penial bulb; *m.*, muscles around the penial bulb; *g.*, ventral clitellar gland.

25. The Relationship of the Big Game of Africa to the spread of Sleeping Sickness. By Dr. W. YORKE, Liverpool School of Tropical Medicine *. With an Appendix containing Remarks by Sir JOHN BLAND-SUTTON, F.R.C.S., F.Z.S.; GUY A. K. MARSHALL, F.Z.S.; Prof. E. A. MINCHIN, M.A., F.R.S., V.P.Z.S.; The Hon. L. WALTER ROTHSCHILD, D.Sc., F.R.S., F.Z.S.; Sir HENRY SETON-KARR, K.C.M.G., F.Z.S.; and Sir ALFRED SHARPE, K.C.M.G., LL.D.; and Reply by Dr. YORKE.

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Although Sleeping Sickness has been recognised as a disease on the West Coast for nearly two hundred years, human trypanosomiasis was unknown in Nyasaland and in the greater portion of Rhodesia until 1908. At the end of that year the first case of the disease was found in Nyasaland, and during 1909 and 1910 a considerable number of cases were discovered amongst the Europeans and Natives living in Nyasaland and Rhodesia. This state of affairs was not easy to understand, as the particular tsetse fly, *Glossina palpalis*, which is known to transmit Sleeping Sickness in other parts of Tropical Africa, has not been found in these countries.

In 1910, it was shown that the parasite causing the disease in Nyasaland and Rhodesia differed in certain respects from that

* Communicated by GUY CHETWYND, F.Z.S.

causing Sleeping Sickness in other portions of Tropical Africa. The name *Trypanosoma rhodesiense* was given to this new parasite.

Since these discoveries many cases of Sleeping Sickness have been found in Rhodesia and Nyasaland, and in 1911 the Chartered Company decided to have the matter thoroughly investigated ; it was with this object that Dr. Kinghorn and I were sent to North Eastern Rhodesia.

The first problem that we had to solve was to ascertain the vector responsible for the spread of Sleeping Sickness in a country where *Glossina palpalis* does not exist. Now although *Glossina palpalis* has not been found either in Nyasaland or in the Luangwa Valley of Rhodesia, yet *Glossina morsitans*, the tsetse fly which is known to cause "fly" disease in domestic stock, is present in enormous numbers, and it was soon proved by Dr. Kinghorn and myself that it is this fly which is responsible for the spread of human trypanosomiasis. This discovery is one of great practical significance, for whereas the former fly, *Glossina palpalis*, is limited in its distribution to water-courses, and is never found far from the banks of certain rivers or the lake shores, the latter, *Glossina morsitans*, is ubiquitous, its distribution being quite independent of water. Hence, it is at once obvious that it is impossible to attempt to deal with Sleeping Sickness in Rhodesia and Nyasaland by any such simple method as removing the native population back from the water-courses and lake shores—a procedure which was attended with such remarkable results in Uganda. The problem of preventing the spread of Sleeping Sickness in these countries, which a few years ago were thought to be in no danger, is one of infinitely greater difficulty than was that which had to be faced in Uganda.

A large number of wild *Glossina morsitans* was examined in the Luangwa Valley in order to ascertain the proportion capable of infecting man with trypanosomiasis. This information is important, as it affords an approximate idea of the potential danger of the district. We found that 1 in 500 wild *Glossina morsitans* was infective in nature. This is an astonishingly large proportion, and it is at once evident that some host other than man must be infected with the human trypanosome in order to account for the large number of naturally infective *Glossina morsitans*. With the object of ascertaining what was the chief vertebrate reservoir of the virus, we examined a large number of the wild fauna of Africa. In all, we examined 250 wild animals (including elephant, rhinoceros, hippopotamus, lion, buffalo, 14 different kinds of antelope, caracal, galago, squirrel, genet, hunting dog, giant rat, and wild rabbit), 256 monkeys, 35 domestic stock, 142 wild rats, and 15 wild mice, making a total of 698. The results were striking, a large proportion of the antelope being found to be infected with the parasites which cause Sleeping Sickness in man and trypanosomiasis in domestic stock. As a conservative estimate, the percentage of big game infected with

the trypanosomes of man or domestic stock might at Nawalia in the Luangwa Valley be placed at 50, and at Ngoa on the Congo Zambesi watershed at 35.

TABLE I.—Percentage of various species of game found infected with trypanosomes pathogenic to man or domestic stock at Nawalia, Luangwa Valley.

Animal.	Number examined.	Percentage harbouring trypanosomes.
Bushbuck	9	66·6
Waterbuck	28	60·7
Kudu	7	57·1
Hartebeest	6	16·6
Roan	8	12·5
Warthog	9	11·1
Puku	10	10·0
Mpala	29	6·9

TABLE II.—Percentage of various species of game found infected with trypanosomes pathogenic to man or domestic stock at Ngoa, Congo Zambesi watershed.

Animal.	Number examined.	Percentage harbouring trypanosomes.
Sitatunga	2	50·0
Waterbuck	27	44·4
Eland	15	26·6
Duiker	9	22·2
Roan	5	20·0
Puku	8	12·5

This investigation, therefore, made it perfectly clear that the main reservoir of the trypanosomes of man and domestic stock is the big game.

Having ascertained these two essential facts, namely that the tsetse fly, *Glossina morsitans*, is the vector by which the disease is spread, and that the big game is the inexhaustible reservoir of the virus which causes the disease, we are faced with the problem

of what, in the light of this knowledge, can be done to stamp out Sleeping Sickness or to limit its spread in Nyasaland and Rhodesia. Obviously the most satisfactory means of prevention would be the extermination of *Glossina morsitans*, which conveys the parasite from one vertebrate host to another. Unfortunately, however, this is out of the question at the present stage of our knowledge. The only known method of getting rid of the fly from a district is by clearing away the bush. In the immediate vicinity of villages such a procedure is doubtless feasible and would be attended by valuable results, and natives should be encouraged to do everything possible in this direction. The labour involved in clearing large tracts of country would, however, be so great that this can be at once set aside as impracticable. Moreover, it must be remembered that not only would the country have to be cleared, but it would require to be kept cleared. Everyone who has had experience of Tropical Africa is familiar with the dense shrub growth which springs up in the site of old garden clearings, two or three years after the natives have ceased cultivating the land. This shrub growth is exceedingly favourable to *Glossina morsitans*, so that unless the country be constantly kept cleared the last state of the district is worse than the first.

At present but little is known of the bionomics of *Glossina morsitans*. The results of investigations carried out up to the present indicate that this tsetse fly has no particular breeding places, but that its pupæ are deposited in a more or less haphazard manner in hollow trees and excavations where they are not likely to be disturbed by game-birds. Regarding the liability of the fly to disease and of its natural enemies we know nothing. Much more information is required on this subject, but it seems only too obvious that the investigations will be beset by great difficulties and that the information will only be forthcoming as the result of much slow and tedious work. In fact, to those familiar with *morsitans* country the extermination of the fly must seem an almost impossible procedure.

In Uganda, where the disease is spread by *Glossina palpalis*, the removal of the population a short distance away from the lake shores and water-courses was followed by most excellent results. Such a measure, however, is impossible in Nyasaland and Rhodesia, where the vector *Glossina morsitans* is practically ubiquitous in its distribution and not limited to water-courses as is *Glossina palpalis*.

In view of the impossibility of exterminating the fly and of the equal impossibility of removing the population from the fly belts, we must consider the only way that remains of combating the disease, that is the advisability of attempting to destroy the reservoir of the virus. It is obvious that the mere isolation of infected human beings is futile in view of the fact that the main reservoir of the virus is the blood of the big game.

And now we come to a subject to which I particularly wish to

draw your attention—a subject which has excited considerable controversy already, and one which will, I expect, excite still more in the near future. I refer to the connection between big game on the one hand and trypanosomiasis of man and domestic stock on the other.

Since the beginning of last year, when Dr. Kinghorn and I published our paper announcing the fact that a large proportion of the wild fauna of Africa harboured the trypanosomes of man and domestic stock, a considerable polemic has arisen over the question of the advisability of attempting to exterminate the big game in the vicinity of human habitations.

In discussing this subject, it appears to me that I could not do better than attempt to answer some of the objections which have been raised against any prophylactic measure being adopted which involves interference with the African fauna.

It has been suggested that if the big game be destroyed in any district, the fly, being deprived of its natural source of food, might turn its attention solely to man and his flocks and herds. It appears to me that but little importance should be attached to this hypothesis. In the first place, cattle do not as a rule live in the presence of *Glossina morsitans*. It was suggested that cattle and other domestic stock might harbour the human trypanosome for considerable periods without detriment to health. This, however, is not true in the case of the human trypanosome of Nyasaland and Rhodesia, which we proved rapidly killed horses, cattle, donkeys, goats, and dogs. Moreover, even if the human parasite did not kill domestic stock, these would still die from the ordinary cattle trypanosomes such as *T. pecorum*, *T. narium*, and *T. vivax*, with which we found the wild *Glossina morsitans* to be heavily infected; so that it is quite obvious that domestic stock cannot have the same significance as a reservoir of the virus as the antelope, which are tolerant of the trypanosomes pathogenic for man and domestic stock. Secondly, the tsetse fly does not invade the clearings in and around villages to any great extent, and therefore man is only attacked when for any reason he goes forth into the bush, and it is hard to believe that he would suffer to any much greater extent in the absence of game. Thirdly, and this is the most important point: if the game were removed the reservoir of the virus is destroyed, and therefore in a short time the fly would tend to become non-infective. The bite of a non-infective *Glossina morsitans* hurts nobody. Finally, there is absolutely no evidence indicating that if the big game in any particular district were slaughtered, the tsetse fly, unable to obtain blood from these animals, would attack man and the domestic animals to a greater extent than at present. It might equally well be argued that if the food-supply of the fly be removed the fly would disappear. There is, moreover, a considerable amount of evidence that the tsetse fly spreads with the game. For example, since the rinderpest swept through Central and South Africa sixteen or seventeen years ago the big game have increased

enormously in numbers, and with this increase in game there has been a corresponding increase in the number of tsetse fly. At Nawalia, in the Luangwa Valley, where we were stationed, *Glossina morsitans* was present in enormous numbers, and natives sent out to collect the flies had no difficulty in capturing large numbers within a short distance of the laboratory. Nawalia is the site of an old Government station which was closed a few years ago on account of Sleeping Sickness. The magistrate who was stationed there in 1905 told me that he only occasionally saw tsetse flies in this district at that time.

Again, it has been suggested that the big game might be only one of the reservoirs of the disease, and that the infection might equally well be conveyed by the small vermin. It must be remembered, however, that the small vermin are to a considerable extent nocturnal in their habits, and although *Glossina morsitans* does occasionally bite at night, especially when the moon is full, yet nobody who has lived in "fly" areas can have any doubt but that this is exceptional, and that for practical purposes the fly feeds in the daytime only. Dr. Kinghorn and I examined a large number of small vermin—rats, mice, wild rabbits, etc.—without finding a single instance of natural infection. Furthermore, it might be remarked that there is no evidence to show that the small vermin are tolerant of the human trypanosome as are the big game. In those which we infected experimentally the disease ran an acute course and the animals died. If this be the case with the majority of the small vermin, they cannot have the same significance as reservoirs of the virus as have the big game, which can probably harbour the parasite for long periods of time without exhibiting signs of disease.

We return, therefore, to the original position. The big game is the natural reservoir of the infection, and the rôle of the tsetse fly, *Glossina morsitans*, is to transfer the virus from the big game to man and his flocks and herds. At the present state of our knowledge we are unable to attack successfully the tsetse fly, nor, unfortunately, is there any prospect of our being able to do so in the near future. Whether anything would be gained in this direction by slaughtering the big game is still a moot point: therefore I will not consider this side of the question, but advocate the advisability of attempting to drive back the game from inhabited regions solely because the game are the reservoir of the infection.

It has been asserted that the power to slaughter all game animals in an infected district is unsound in principle, because the game, when harried, would betake itself to places difficult of access to man, or scatter in small herds, or in pairs, or singly, over wide areas, and that should this occur, it is highly probable that it might be followed by tsetse, thus spreading the danger of infection to wide areas now free from game and fly.

To such criticism as this it is not difficult to reply. If the game when harassed betook itself to places difficult of access to

man, surely this is exactly what is desired. In such places it would no longer be a menace to civilisation.

Regarding the second alternative, that the hunted game might scatter into small herds or in pairs and be followed by the tsetse fly, thus spreading the infection over large districts, the obvious rejoinder is that should this occur the game must be destroyed in the new areas, provided these happen to be inhabited regions. Such a contingency is, however, very unlikely, as it is very questionable if small herds of hunted game scattering over wide areas would cause the tsetse fly to migrate with them.

The Colonial Secretary pointed out that "To talk of the extermination of the wild fauna of a subcontinent was to talk wild nonsense." This is perfectly true, but it is no reason why the game in the vicinity of human habitations should not be destroyed. It was further stated by the Colonial Secretary that an attempt made in Nyasaland to get the game in a certain area killed off was, after twelve months, unsuccessful, though the natives were encouraged to shoot. This, again, is no argument against the policy suggested, but merely a confession that the experiment was not efficiently performed. In this connection it is of interest to note the remarks of Dr. J. B. Davey at a recent meeting of the Society of Tropical Medicine. He said:—

"I do not think there would be much difficulty in doing this (destroying the game) if the natives were employed. It is work they would take up with some avidity. Having lately been a member of the Commission in Nyasaland, I remember that considerable anxiety was expressed lest we should not be able to get sufficient material, because during the previous year fifty rifles had been served out in that area, and the natives had been encouraged to shoot game. If in that short time fifty rifles could clear a large area like that, after a year or two they could make a great impression. As a matter of fact, that permission was only in force for about three months, and they made a considerable impression on the amount of game."

Such experiments as these are unsatisfactory, and do not yield any definite results. For any reliable information to be obtained, it is necessary that the work should be done in a scientific manner, and on a sufficiently large scale in some particular district. A locality which is fairly well populated and which contains plenty of tsetse fly and game should be chosen. An exact census of the population should be made, and the proportion suffering from Sleeping Sickness determined. The same must be done in the case of the domestic animals, if such exist. An index of the percentage of infective tsetse fly must be ascertained. This is most important, as it gives one a definite idea of the potential danger of the district. Finally, the game must be completely eradicated, and at the same time the percentage infected with the human and cattle trypanosome determined, and when once the game has been driven out, it must be kept back by vigorous action and not allowed to return. After an interval

of a couple of years or so the population, domestic stock, and tsetse fly must again be carefully examined. Then we should be in a position to decide definitely whether or not driving the fauna back from the site of human habitations would pay. Such an experiment as this would take some years to accomplish. That the big game is the reservoir of the human infection there can no longer be any doubt, as the work of Kinghorn and myself has already been confirmed. I submit, therefore, that the time for temporising is past. Sleeping Sickness has already crossed the Zambesi, and cases have been recorded in Southern Rhodesia. In my opinion the natives living in fly areas should be allowed to kill game in their own way, and they might also to an extent be armed with rifles of some uncommon bore, so that a control could be kept over the ammunition. Europeans ought to be allowed to shoot what they like. Protecting the reservoir of the trypanosomes causing fatal disease in man and his flocks and herds by heavy licences, appears to be rather an anomaly. Finally, I consider that some such decisive experiment as I have outlined is urgently required, as even under the most favourable conditions several years must elapse before we should be in a position to recommend definitely that vigorous steps be taken to drive back the big game from the neighbourhood of human settlements on a large scale throughout Tropical Africa.

It may seem an act of vandalism to slaughter the wonderful fauna of Africa; but surely when it is definitely proved that this fauna is antagonistic to civilization, then that which stands in the path of progress must be removed.

A P P E N D I X.

SIR JOHN BLAND-SUTTON, F.R.C.S., F.Z.S., did not feel qualified to express an opinion of value in regard to the drastic scheme for extirpating the living reservoirs of Sleeping Sickness proposed by Dr. Yorke. It is not always necessary to destroy the reservoirs of a disease in order to protect human beings from infection. For example, when bacteriologists discovered that the goats of Malta, from which the island derives its milk supply, were the reservoirs of the *Micrococcus melitensis*, the cause of Malta (or Mediterranean) fever, the Governor was strongly urged to order the wholesale destruction of the goats. He explained that such an order would bring about a revolution in the island, for the Maltese are devoted to their goats. The micrococcus is conveyed in the milk; it was a simpler plan to banish goat's milk from the military and naval dietary. Sailors and soldiers at Malta are not now allowed to drink goat's milk; as a consequence, Malta fever has disappeared from the Navy and the Army.

It is probable that the band of bacteriologists and entomologists (of which Dr. Yorke is a brilliant member) engaged in

studying Sleeping Sickness will find some prophylactic or remedial measure less obnoxious than the wholesale destruction of the great game animals of Africa.

MR. GUY A. K. MARSHALL, F.Z.S., urged that the essential question for consideration was whether or no the game constituted a reservoir of *Trypanosoma rhodesiense*, as opposed to *T. brucei*; and from this point of view it was somewhat unfortunate that in giving his percentages of infected game Dr. Yorke had lumped these two forms together, as this might possibly lead to misconceptions. He felt very strongly that the unqualified statement that human trypanosomiasis had "spread" to south of the Zambezi was not justified in the present state of our knowledge, and might well cause unnecessary alarm. He agreed with Mr. Austen that there was no evidence to show that the disease was really spreading in the countries north of the river, though its existence there had now been known for nearly five years. A few years ago, when sporadic cases of Sleeping Sickness were first discovered in Nigeria, the fear was expressed that an epidemic similar to that in Uganda would take place. Yet no epidemic had occurred, nor was such an event probable; for it was now generally recognised that the disease is there endemic, the bulk of the population being therefore immune, and these sporadic cases merely indicated that more or less susceptible individuals are still being born. The incidence of human trypanosomiasis in Nyasaland and Rhodesia presents a very striking similarity with that which we find in West Africa, and, in conjunction with other considerations, strongly suggests that we are dealing, not with a new disease, but with one which has already been endemic for some time and has merely escaped detection, as in West Africa. If this be a sound conclusion, we must recognise the probability that the immune natives may themselves be reservoirs of the trypanosome, in which case Dr. Yorke's assumption that the removal of the game must necessarily eradicate the disease may prove entirely fallacious. Finally, Mr. Marshall pointed out that Dr. Yorke had recorded that 1 in 500 of the wild flies was infected with *T. rhodesiense*, and had referred to this as an unusually high percentage. But the latter statement seemed hardly in accord with the results obtained by other workers, and notably the data for *T. cazeltoni* and *T. gambiense* given by Roubaud in a recent paper. Indeed, considering the high percentage of infected game in the Luangwa Valley, as estimated by Dr. Yorke, his record of infected flies seemed quite remarkably low and did not suggest any probability of an epidemic.

In considering any measures for coping with human trypanosomiasis in Rhodesia and Nyasaland, it is a matter of the very highest importance, especially from an administrative point of view, that we should ascertain whether the disease is really a new one in those countries, or whether it is merely endemic. The

matter was so inadequately discussed when Dr. Yorke read his paper to the Society that it seems desirable to consider it here in somewhat greater detail. In his published papers Dr. Yorke has throughout assumed the disease to be a new one, and gives no sign of having even contemplated the other alternative. When, at the meeting referred to, I suggested that the disease is probably endemic, and that in consequence immune natives may prove to be a reservoir of the trypanosome, he rejected the suggestion on the grounds (1) that the disease had only recently been discovered, and it was incredible to suppose that so distinctive an organism as a trypanosome had been previously overlooked by medical men; and (2) that the virulence of the disease was so great in all the cases of infection investigated (there being no recoveries) that he found it impossible to believe that human beings could harbour this organism with impunity.

As one who resided in Southern Rhodesia for nearly thirteen years, I cannot seriously accept the first of these arguments. The methods of blood-examination which are now matters of every-day routine for any young doctor trained in our modern Schools of Tropical Medicine, were certainly not practised in Rhodesia until quite recently, and the chances of the disease being correctly diagnosed, at least up to 1906, would have been extremely remote. With regard to the second contention, the mere fact that a disease is highly virulent in susceptible persons is no valid evidence as to the non-existence of immune individuals. It is now generally admitted that the natives of West Africa are very largely immune to *Trypanosoma gambiense*, and there seems to be no good reason for assuming that a similar power of resistance to *T. rhodesiense* cannot exist in East Africa. Indeed, the more virulent the disease, the more rapid will be the development of a general immunity; and further, the more deadly the parasite, the less likely are there to be intergrades between complete immunity and fatal susceptibility in the host.

It is true that a new disease will usually exhibit what is known as primary virulence; but this virulence is essentially in relation to population, and not merely in relation to the individual. In other words, we may reasonably assume a disease to be newly introduced if there is a very high percentage of cases and a low percentage of recovery; but if the percentage of cases is small (as it certainly is in Rhodesian trypanosomiasis), the individual severity is no proof that the disease is new. To take an example. The endemicity of yellow fever in West Africa is now hardly disputed, yet in the epidemics in Accra and Sekondi in 1910 to 1912, out of 23 Europeans attacked no fewer than 22 died. Another aspect is perhaps worth consideration. There can be no question that Sleeping Sickness was a new disease in Uganda, and there was a marked primary virulence in its true sense; yet in spite of this, the individual course of the malady, though eventually fatal, was less severe and much less rapid than in Rhodesian trypanosomiasis.

The position, then, is as follows. We have in Rhodesia and Nyasaland a very virulent form of trypanosomiasis, carried by a *Glossina* which has a wide local distribution and which is a much more persistent biter than *G. palpalis*; and, further, a considerable percentage of the game is estimated to be infected by *T. rhodesiense*. If this be really a new disease, it would seem that the native population is faced with an epidemic beside which that in Uganda would be a mere circumstance, and the most drastic remedies that youthful enthusiasm can devise would appear to be justified.

On the other hand, we have to consider that the disease has been known to exist in this area for nearly five years and has probably been there a good deal longer; for we can hardly be asked to believe that by a remarkable coincidence *Trypanosoma rhodesiense* chanced to be discovered at the precise moment of its origin. Yet, in spite of the presence of these factors making for the rapid development of a severe epidemic during all these years, nothing of the kind has happened; nor have we any real reason to suppose that an epidemic is imminent. The evidence, such as it is, seems to indicate that we are dealing with an endemic disease, which is not likely to become worse if the present conditions are maintained. And while further experimental investigations should certainly be carried on, there is no justification for anything in the way of panic legislation.

PROFESSOR E. A. MINCHIN, M.A., F.R.S., F.L.S., V.P.Z.S., said that in Dr. Yorke's paper he had heard nothing to criticise or controvert, so far as statements of fact were concerned. The two African trypanosomes deadly to man, namely *Trypanosoma gambiense* and *T. rhodesiense*, were members of a large group of trypanosomes which was typified by the well-known *T. brucei*, and might therefore be called the *brucei*-group. There could be hardly any doubt, in the present state of knowledge, but that the *brucei*-group of trypanosomes was one which was primitively parasitic upon wild ungulates, and that many species had been carried secondarily by the agency of biting flies to other vertebrate hosts, in which they had been able to maintain themselves. The fact that the trypanosomes of this group were harmless to the wild ungulates but deadly to other animals showed that the former were their natural hosts. Thus, *T. gambiense* and *T. rhodesiense* were harmless to antelopes but deadly to man; *T. brucei* was harmless to wild ungulates but very deadly to domesticated horses, cattle, or dogs. This conclusion did not apply, however, to the human trypanosome of Brazil, *T. cruzi*, nor to cattle trypanosomes of the *theileri*-type, forms which were quite distinct from the *brucei* group.

While agreeing with Dr. Yorke on matters of fact, Prof. Minchin thought that in the present state of our knowledge the utmost caution should be exercised in putting into practice administrative measures based upon the data so far established. The inter-

relationship of different organisms in nature was very complex, and a sudden change brought about in the conditions might have results altogether different to what was anticipated originally. Dr. Yorke had argued, it seemed to him, as if the distribution and occurrence of tsetse-flies were fixed and immutable, and had denied that there was any danger of their migrating towards human habitations if the big game, their natural source of food in the bush, were destroyed. Prof. Minchin found it difficult to believe, however, that if the tsetses in the bush were deprived of their food, they would sit down and die of starvation ; he thought it far more probable that the flies would migrate in search of food, which they would find in human beings and the cattle surrounding their habitations. [Dr. Yorke maintained that the shelter of the bush was necessary for the flies ; but such shelter might be found on cultivated land, especially in the banana-plantations which often surrounded native huts or villages.]

Considering the question, therefore, purely from a utilitarian point of view, Prof. Minchin thought it within the bounds of possibility, to say the least, that the wholesale destruction of the big game might lead to a condition of things more dangerous and disastrous than that existing at present. He urged that such measures should be undertaken, at first experimentally, on a small scale and in a restricted area, in order that accurate knowledge might be obtained of the effects produced by the elimination of the wild ungulates before destroying them wholesale.

*Letter from THE HON. L. WALTER ROTHSCHILD,
D.Sc., F.R.S., F.Z.S.*

Dear Dr. CHALMERS MITCHELL,

I am extremely sorry that, as I leave for Monaco on the 18th, I cannot attend the meeting. But I trust you will read this letter at the meeting. Dr. Yorke suggests the extermination or partial extermination of the ruminants and large game animals. I wish to protest against this most emphatically on zoological and ethical grounds. However, in order to prove to the utilitarians the absolute uselessness of this proceeding, I should like to point out that the extermination of the game animals in any large area would be a task of several years' duration, and the following would take place. As year by year the large animals grew scarcer, the tsetse-flies *Glossina palpalis* and *morsitans*, which are the means of spreading Sleeping Sickness in men and N'gana in animals, would be driven to bite monkeys, carnivora, rats, mice, and the numerous small animals of those regions ; these would be infected and the trypanosomes of the disease would gaily survive. This would not only mean the continuance of the disease in its present degree, but would cause a sharp increase of both diseases. The reason for this increase, to my mind, would be very evident, for at present, owing to the abundance of large game animals, the

flies do not on sight attack *every human being* or *domestic animal* they perceive; but once let them be reduced to small animals for their normal supply of blood, it is certain that on the first appearance of any *domestic animal* or *human being* they would instantly precipitate themselves on it. This would mean that many more would be bitten than at present, and many more cases of the disease would occur. I am sure if the game is exterminated, the fly will not be; and, on the contrary, the disease will be increased and not diminished.

Yours sincerely,

Zoological Museum,
Tring,
Herts, England.
March 15th, 1913.

(Signed) WALTER ROTHSCHILD.

March 15th, 1913.

Letter from SIR HENRY SETON-KARR, K.C.M.G., F.Z.S.

Dear Dr. CHALMERS MITCHELL,

I am exceedingly sorry I cannot attend the meeting to-night to hear Dr. Yorke's paper on the relation of Big Game in Africa in spreading Sleeping Sickness, and the discussion thereon.

The subject is one of deep interest and importance, to which I gave considerable attention during my travels in South and East Africa in 1911. So far as my own information and observation go, I am entirely opposed to any proposed destruction of Big Game, or any relaxation of the restrictions on the shooting of game until the case against them as spreaders of Sleeping Sickness has been fully and clearly established, which is far from being the case at present.

The subject was fully discussed in the South-African press a few years ago by many well-known authorities, and I would suggest that the letters on this subject be, if possible, obtained, printed, and circulated.

The main difficulties of the problem, as I understand them, are:—

1. That there would appear to be other agencies, apart from Big Game, that spread this dreadful scourge, and that some of these agencies have yet to be ascertained.
 2. That inasmuch as there are Sleeping Sickness areas where Big Game are not plentiful, and Big Game areas where there is no Sleeping Sickness, the direct connection between the two has yet to be fully established.
 3. That other causes exist for the spread of the disease, such as, for example, the greater freedom of intercourse among native tribes under white protection.
 4. That the destruction of Big Game in any given areas is a task of immense difficulty, which, if attempted, might not have the desired effect. Some game would merely be driven elsewhere, and the smaller mammals and game be left, which are also a possible spreading agency of the disease.

I feel sure that Dr. Yorke will initiate a most interesting and valuable discussion, and no doubt throw new light on this important and mysterious subject. But I earnestly deprecate any too hasty or premature a conclusion on the matter, and before all authorities have been fully heard and consulted. If it is conclusively shown that Big Game undoubtedly spread Sleeping Sickness, then Big Game must go. On the other hand, it would be an irreparable calamity of the worst kind to permanently injure or destroy the indigenous wild life of Africa *to no purpose*, and this might be the result of premature action.

Yours truly,

47 Chester Square, (Signed) HENRY SETON-KARR.
London, S.W.
March 18th, 1913.

SIR ALFRED SHARPE, K.C.M.G., LL.D., remarked : "The question appears to resolve itself into the following heads :—

- " 1. What varieties of tsetse are proved to be carriers of the trypanosomes of any form of Sleeping Sickness, and (which is even more important) what *other* carriers are there ?
- " 2. Does tsetse really depend entirely on game for its existence ?
- " 3. Assuming even that tsetse are the only distributing agents of all forms of Sleeping Sickness—and that fly depends solely on game for its existence—is it possible to destroy every form of life upon which tsetse can exist ?

" There is a desire on the part of a certain section of the European population of our African possessions to do away with all restrictions on the killing of game. This is fomented in some cases by the local press; and every argument is made use of which may further their object. In most cases those who carry on this local agitation are ignorant of the actual conditions governing the existence of tsetse, and its relation to game and to Sleeping Sickness.

" 1. With regard to my first heading. We know that *Glossina palpalis* is considered to be the only distributing agent of Sleeping Sickness in Uganda. *G. morsitans* is now credited, however, with being a distributor in Nyasaland and N.E. Rhodesia. What we require as regards *morsitans* is (*a*) more definite proofs that it distributes under natural conditions, (*b*) more knowledge as to whether there are not other distributing agents in Nyasaland and Rhodesia. It is remarkable that in these two districts, in spite of the fact that *G. morsitans* exists not only in the low country but up to a height (in Rhodesia) of 4000 feet above sea-level, Sleeping Sickness has only been found under the same conditions as in Uganda, *i. e.* in close proximity to the banks of the large rivers and lakes.

" 2. As to the second heading, my experience is opposed to the

supposition that tsetse depends solely on game for its existence. There are striking instances in Nyasaland and Rhodesia of gameless districts full of fly, and flyless districts full of game.

"3. Referring to the third heading—how would it be *possible* to annihilate game? It must be remembered that it is not only what is known as 'big game' that fly feeds on, but *all* game, big and small, and almost every form of life in the bush. It would be necessary to annihilate practically every form of life and to remove also every native. This would obviously be impossible.

"In any case it would be a terrible mistake, which could never afterwards be remedied, to countenance anything in the shape of an attempt to annihilate game in any part of Africa, unless we are *absolutely certain beforehand* that such a course would not only ensure the extinction of all varieties of tsetse fly, but make sure that all forms of Sleeping Sickness would disappear. At present the grounds for such an assumption are totally inadequate."

Reply by Dr. W. YORKE.

As it is impossible in the limited time at my disposal to reply in full to the volume of criticism which my paper has evoked, I must content myself with dealing with a few of the more important and useful points which have been raised.

Mr. Marshall points out that in giving the percentages of infected game I grouped together all the trypanosomes pathogenic to man and domestic stock, and that this might lead to misconception. In our published papers Dr. Kinghorn and I have separated the parasites one from the other, and full particulars are given as to number of each antelope infected with each of the various pathogenic trypanosomes. I might state here that at Nawalia in the Luangwa Valley 16 per cent., and at Ngoa on the Congo-Zambesi watershed 3·3 per cent., of the wild animals were infected with *Trypanosoma rhodesiense*. The statement that in my published papers I have throughout assumed the disease to be a new one in these countries, and not even contemplated the other alternative, is incorrect. Whether the disease be new or old appears to me to be only of secondary importance. What is of the first importance, however, is whether or not the disease is spreading—whether more cases are occurring now than, say, eight or ten years ago. I admit that from the statistics available the question is difficult to answer; but what evidence there is suggests strongly that during the past few years sleeping sickness has been on the increase. Obviously the most reliable information is to be obtained from an examination of the incidence of the disease in Europeans. I cannot think it likely that even anterior to 1909 many white people could have succumbed from trypanosomiasis without the disease having been recognised; yet in spite of the fact that the main roads to the Congo-Zambesi watershed crossed the Luangwa Valley, and that these roads were traversed by

large numbers of European officials and others, it was not until towards the end of 1909 that the first white case was discovered. Since then, although the Luangwa Valley has been closed, quite a number of Europeans have contracted the disease in North-Eastern Rhodesia. Moreover, we must remember that some time before 1909 scientific experts had travelled through the Luangwa Valley without discovering a single case either native or European.

The hypothesis that human beings can harbour a parasite for long periods of time, as do the wild fauna, without exhibiting signs of disease, is one which I cannot support. Amongst the cases discovered by us, several presented practically no symptoms, the only indication of the disease being the presence of trypanosomes in the blood ; yet without exception they were all dead within six months.

Professor Minchin suggests that if the game in a "fly" area were destroyed, the "fly" would enter the villages and attack human beings and the cattle surrounding their habitations. To this objection I have already referred in my paper. Cattle are not as a rule found in villages situated in "fly" districts, and the "fly" does not invade villages around which there is a clearing, even though at the present time they could by so doing obtain food still more readily than they do in the bush.

Regarding the letter of the Hon. Walter Rothschild, I have already in my paper discussed the suggestion that after the extermination of the game the fly would be driven to attack monkeys, rats, and mice. Even if this occurred, these animals quickly succumb from trypanosomiasis, and therefore cannot have the same significance as reservoirs of the disease as the big game which are tolerant of the parasites.

With regard to the first objection raised by Sir Henry Seton-Karr, I must ask what are the other reservoirs of the virus ; and if there be any, is that a reason why the main reservoir should not be destroyed ? Passing to the second point, I submit that the connection between big game and sleeping sickness has been fully and amply established. As to the third point, the greater freedom of intercourse among native tribes under white protection has undoubtedly played a part in the spread of the disease. But if civilisation and progress is to continue, this freedom of intercourse must also continue, and the population will of necessity run more risk of infection than previously. Recognition of this fact makes it all the more essential that we should endeavour to render the "fly" as non-infective as possible by destroying the reservoir of the virus. As the last point is fully discussed in my paper, I need not refer to it again.

In reply to Sir Alfred Sharpe, I must point out that we have established beyond all doubt that *Glossina morsitans* does transmit sleeping sickness under natural conditions. I cannot see how further knowledge as to whether there are other distributing agents affects the question, beyond the fact that if this be proved

to be the case it merely emphasizes the almost hopelessness of attempting to get rid of the transmitting agents, and demonstrates clearly that if anything is to be done it must be in the direction of destroying the reservoir from which *Glossina morsitans* and the other (hypothetical) vectors derive their infection.

As I pointed out in my paper, whether the tsetse fly depends entirely on game for its existence is beside the question. This subject has already been most fully discussed on more or less theoretical grounds, and we now require facts, and not further discussion. Definite information on this, as on many other points raised in this discussion, can only be obtained by means of the limited experiment which I advocate.

In conclusion, may I state my position once more. I have not, as some of the speakers appear to think, made the wild statement that the whole of the game in Tropical Africa should be destroyed, but merely that the restrictions should be removed in "fly" areas, and that natives and Europeans should be encouraged to kill game in these areas, especially in the vicinity of human habitations. Finally, I am strongly of the opinion that some such limited experiment as I have outlined should be undertaken, as it is only by this means that the data necessary for our guidance in the future can be accumulated.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

March 4th, 1913.

Dr. A. SMITH WOODWARD, F.R.S., Vice-President, in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

Dr. S. F. HARMER, M.A., F.R.S., exhibited a hair-ball which was presented to the British Museum (Natural History) by Mr. A. Dobrée, in January 1911. Alluding to Mr. E. G. Boulenger's exhibit, on February 18th last, of spines of a Madagascar Insectivore in the excrement of a Boa, he pointed out that this was perhaps another case of the occurrence of spiny hairs in the alimentary canal of a reptile. Mr. Dobrée's specimen, which has been described by Mr. R. Lydekker, F.R.S., in 'The Field,' vol. 117, Feb. 25, 1911, p. 383, was found in the Province of Morondava, West Coast of Madagascar, between Belô on the Tsiribihina River and Bevilô; and it has the form of a hair-ball, consisting largely of the hairs of Tenrecs (*Centetes*). Bearing Mr. Boulenger's results in mind, it is possible that the specimen in question may have come from a Boa; but it seems to be more probable that it came from the stomach of a Crocodile. The principal reason for coming to this conclusion is the evidence supplied by Mr. J. Simão da Costa to the British Museum that hair-balls of this nature occur in the stomachs of Crocodilians in N. Brazil, as recorded by Mr. Lydekker in the note above referred to.

Mr. E. G. BOULENGER, F.Z.S., Curator of Reptiles, made remarks on the Lung-Fish, *Protopterus aethiopicus*, which the Society had recently received from Mr. C. W. Woodhouse, and which was the only Dipnoan that had not previously been exhibited alive in Europe.

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Dr. P. CHALMERS MITCHELL, F.R.S., F.Z.S., Secretary of the Society, exhibited a lantern-slide made from a photograph of a domestic Donkey (*Equus asinus*) taken by Captain C. H. Armitage in the Gold Coast, and showing a very remarkable pattern of transversely arranged black stripes on the flank.

Dr. F. E. BEDDARD, M.A., F.R.S., F.Z.S., Prosector to the Society, read a paper on the Anatomy and Systematic Arrangement of the Cestoidea, in which he described a new genus of Tapeworms, of the family Ichthyotæniidæ, from the Crossed Viper (*Lachesis alternans*).

Dr. W. A. CUNNINGTON, M.A., F.Z.S., read a paper on the Branchiura collected by the Third Tanganyika Expedition in 1904–1905. The collection contained over 300 specimens, and proved that in the case of this group of animals also, Lake Tanganyika exhibits a number of endemic forms. While two species of Argulidæ are known to be widely distributed in the lakes of Africa, they are associated in Nyasa with a single form peculiar to that lake, but in Tanganyika with no less than seven new types. Tanganyika is thus shown to possess not only a considerable number of characteristic species, but a much richer Branchiuran fauna than the other great African lakes. The paper was illustrated by lantern-slides made from photomicrographs of the new species.

Mr. WILLIAM SCHAUS, F.Z.S., communicated a paper containing the descriptions of a large number of new species of Rhopalocera from Costa Rica. Over 1000 species had been collected, and of these 54 were found to be new.

A paper was received from Dr. ARTHUR WILLEY, M.A., F.R.S., F.Z.S., containing some notes on Plankton collected across the mouth of the St. Croix River, opposite to the Biological Station at St. Andrews, New Brunswick, in July and August 1912.

The next Meeting of the Society for Scientific Business will be held on Tuesday, March 18th, 1913, at half-past Eight o'clock P.M., when the following communications will be made:—

EXHIBITIONS AND NOTICES.

Dr. W. YORKE.

Remarks on the Relationship of the Big Game of Africa to the spreading of Sleeping Sickness.

EDITH E. BAMFORD.

Variations in the Skeleton of the Pectoral Fins of *Polypterus*.

H. H. STIRRUP, B.Sc.

A Descriptive Study of an Oligochaete Worm of the Family Enchytraeidæ.

The following papers have been received:—

C. TATE REGAN, M.A., F.Z.S.

A Collection of Fishes made by Professor Francisco Fuentes at Easter Island.

A Revision of the Fishes of the Genus *Kuhlia*.

S. F. HARMER, M.A., Sc.D., F.R.S., F.Z.S.

The Polyzoa of Waterworks.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,

Secretary.

ZOOLOGICAL SOCIETY OF LONDON,

REGENT'S PARK, LONDON, N.W.

March 11th, 1913.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

March 18th, 1913.

E. G. B. MEADE-WALDO, Esq., Vice-President,
in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a Report on the Additions made to the Society's Menagerie during the month of February, 1913.

Miss EDITH E. BAMFORD presented a paper, communicated by Dr. H. GADOW, F.R.S., F.Z.S., entitled "Variations in the Skeleton of the Pectoral Fins of *Polypterus*." An examination had been made of the ample material brought back by Budgett from his West African Expeditions, in order to account for the discrepancies which occur in the descriptions of the fins of *Polypterus* as given by different investigators. These discrepancies were found to be due to the very numerous variations in the fins and to the previous scarcity of material.

A description is given of the variations found in the radials, mesopterygium, propterygium, metapterygium, and the distal cartilages, and their bearing on the different descriptions and the theories of other investigators is indicated.

Mr. H. H. STIRRUP, D.Sc., contributed a paper, communicated by Prof. F. W. GAMBLE, F.R.S., F.Z.S., containing a descriptive study of an Oligochaete Worm of the family Enchytraeidæ. A number of new and interesting observations were recorded therein,

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including an account of the structure and significance of the so-called "septal glands," which had been found to contain two definite anatomical components. An appendix to this paper contained an account of some Astomatous ciliate Protozoa, which the author had discovered living commensally in the gut of the worm which formed the basis of his paper. One of these ciliates, the largest and commonest, had been identified as *Mesnilella fastigiata*, but no description had been found of three others discovered along with it, which would probably prove to be new species.

Dr. W. YORKE, of the Liverpool School of Tropical Medicine, read a paper, communicated by Mr. Guy CHETWYND, F.Z.S., on "The Relationship of the Big Game of Africa to the Spread of Sleeping Sickness." The author stated that sleeping sickness in Nyasaland and Rhodesia is due to a different parasite from that causing the disease in other parts of Tropical Africa. In these countries the disease is transmitted by *Glossina morsitans* and not by *Glossina palpalis*. As *Glossina morsitans* is ubiquitous, and not limited in its distribution to water-courses, this fact has an important bearing on the measures that can be recommended with a view to prophylaxis.

The chief reservoir of the virus is the big game, the tsetse-fly transmitting the trypanosome from the big game to man and domestic stock.

In the consideration of prophylactic measures, the impossibility of exterminating *Glossina morsitans* was mentioned, and the removal of population from fly-areas was equally impracticable. The advisability of attempting to destroy the game in the inhabited portions of fly-areas was then discussed, and the necessity of a thoroughly scientific experiment being undertaken, so that definite information of the results of exterminating the game in a particular district may be forthcoming, was recommended.

In the discussion which followed several members and visitors took part, including Prof. E. A. Minchin, F.R.S., Sir Alfred Sharpe, Mr. E. E. Austen, Mr. F. C. Selous, Mr. Guy Marshall, Sir John Bland Sutton, and Dr. S. F. Harmer, F.R.S., and letters were read from the Hon. L. Walter Rothschild, D.Sc., F.R.S., and Sir Henry Seton-Karr, C.M.G.

The general opinion of the Meeting was not in favour of Dr. Yorke's views.

The next Meeting of the Society for Scientific Business will be held on Tuesday, April 8th, 1913, at half-past Eight o'clock P.M., when the following communications will be made:—

EXHIBITIONS AND NOTICES.

C. TATE REGAN, M.A., F.Z.S.

1. A Collection of Fishes made by Professor Francisco Fuentes at Easter Island.

2. A Revision of the Fishes of the Genus *Kuhlia*.

R. I. POCOCK, F.R.S., F.L.S., F.Z.S.

The Affinities of *Canis antarcticus*.

Major G. E. H. BARRETT-HAMILTON, F.Z.S., and M. A. C. HINTON.

On a Collection of Mammals from the Hebrides, Scotland.

The following papers have been received:—

S. F. HARMER, M.A., Sc.D., F.R.S., F.Z.S.

The Polyzoa of Waterworks.

A. W. WATERS, F.L.S., F.G.S.

The Marine Fauna of British East Africa and Zanzibar, from Collections made by Cyril Crossland, M.A., B.Sc., F.Z.S., in the Years 1901-1902. Bryozoa—Cheilostomata.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,
Secretary.

ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W.
March 25th, 1913.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

April 8th, 1913.

Sir JOHN ROSE BRADFORD, K.C.M.G., M.D., D.Sc., F.R.S.,
Vice-President, in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a Report on the Additions made to the Society's Menagerie during the month of March, 1913.

Mr. H. J. ELWES, F.R.S., F.Z.S., exhibited the head of an Asiatic Wapiti remarkable for the outward extension of the bez tines.

Mr. C. TATE REGAN, M.A., F.Z.S., read a paper on Fishes from Easter Island collected by Professor F. Fuentes. The collection included examples of 10 littoral species, 4 widely distributed in the tropical Indo-Pacific and 6 new to science; of the latter 2 were related to tropical forms and the rest to species described from New South Wales or from Norfolk Island.

Mr. REGAN also read a paper entitled "A Revision of the Fishes of the Genus *Kuhlia*"; 12 species were recognized, including 3 described as new to science.

Mr. R. I. POCOCK, F.R.S., F.Z.S., Curator of Mammals, read a paper on "The Affinities of *Canis antarcticus*," in which he

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showed:—(1) that *C. antarcticus* and *C. latrans* are not closely related, as have been claimed; (2) that the affinities of *C. antarcticus* lie with certain South-American species of Canidæ; and (3) that *C. latrans* must be affiliated with the wolves and large jackals of the northern hemisphere. These conclusions were based mainly upon cranial and dental characters, and the points were illustrated by a series of lantern-slides of the skulls of several species of Canidæ.

A paper by Major G. E. H. BARRETT-HAMILTON, F.Z.S., and Mr. MARTIN A. C. HINTON on a collection of Mammals from the Inner Hebrides, was read by Mr. Hinton. This collection had been made during an expedition organized and managed by Mr. W. R. Ogilvie-Grant. Three new forms were discovered: of these one (*Sorex grantii*) is regarded by the authors as an insular development of *S. araneus*, whilst they are inclined to think that the other two (*Evotomys alstoni* and *Microtus agrestis macgillivrai*) are slightly modified survivals from the Pleistocene period.

SOREX GRANTII, sp. n.

Habitat. Islay.

Size rather large (average: head and body 77·3, tail 36, hind foot 12·6 mm.; condylo-basal length of skull 18·2 to 19·3 mm.); colour pattern, the dusky upper side in strong contrast to light flanks; dentition, posterior unicuspids above frequently suppressed, the four remaining unicuspids being then enlarged in compensation.

EVOTOMYS ALSTONI, sp. n.

Habitat. Mull.

Size slightly larger than in *E. glareolus*, approaching that of *norvegicus*; tail shorter than in latter, about as in former; ear and colour nearly as in *glareolus*; hind foot as in *norvegicus* and *skomerensis* (dimensions of type: head and body 108, tail 44, hind foot 18, ear 11 mm.). Skull large as in *norvegicus* (condylo-basal length 24·1–25·3 mm.), jugal heavy, brain-case broad and smooth, convex above in profile instead of flattened, rostrum and bullæ like those of *norvegicus*; posterior cheek-tooth above with the third inner fold and fourth inner salient angle well developed.

MICROTUS AGRESTIS MACGILLIVRAI, subsp. n.

Habitat. Islay.

Similar to *M. a. exsul* in size and general proportions; coat much thinner, the amount of yellowish wash on underside much less, so that slaty bases of hairs take part in general coloration, the upper side slightly less brightly coloured; dental characters conspicuously of the *exsul* type; skull (the comparison being between skulls of equal age) with deeper rostrum, lighter jugal, less sloping occiput, and less reduced interparietal, the anterior portion of temporal muscle not ascending so high upon the

anterior shoulders of the brain-case. Broadly speaking, the external and cranial characters of *macgillivrai* are those of immature *exsul*, which here persist with very little modification throughout the life of the individual.

The authors propose to divide the Western European members of the *agrestis* group into two species, viz.: (1) *M. agrestis*, with the subspecies *agrestis*, *macgillivrai*, *exsul*, *leverniedii*, and *neglectus*; (2) *M. hirtus*, with the subspecies *hirtus* (Southern Britain) and *bailloni* (France). *M. agrestis* is the older inhabitant of the region, and the subspecies *macgillivrai* is regarded as its most primitive known form; *M. hirtus* is a new immigrant, which, in the southern, lowland, or non-insular districts, has replaced *M. agrestis*.

In conclusion, the authors argue that the evidence shows that Islay, and perhaps Jura, was separated from the old Hebridean land-area as well as from the mainland of Scotland earlier than were the other islands. Secondly, they think it likely that the severance of the Hebridean district transpired before that of the Orkneys. Lastly, they consider that the evidence of the mammals supports the suggestion of a former direct land-connection between Western Norway and the Hebrides, put forward by Stejneger.

Mr. R. LYDEKKER, F.R.S., F.Z.S., described, under the name of *Bubalis caama selbornei*, subsp. n., a mounted male hartebeest from the Transvaal, in the British Museum, which differs from the typical *B. caama* by the yellowish-fawn body-colour, the admixture of tawny hairs in the dark markings, the small extent of the face-blaze, which is interrupted by a large tawny interval in the region of the eyes, and by the dark markings on the front of the lower part of the fore legs forming only a cap at the knee and a small patch on the shank,

The next Meeting of the Society for Scientific Business will be held on Tuesday, April 22nd, 1913, at half-past Eight o'clock P.M., when the following communications will be made:—

EXHIBITIONS AND NOTICES.

S. F. HARMER, M.A., Sc.D., F.R.S., F.Z.S.

The Polyzoa of Waterworks.

A. W. WATERS, F.L.S., F.G.S.

The Marine Fauna of British East Africa and Zanzibar,
from Collections made by Cyril Crossland, M.A., B.Sc., F.Z.S.,
in the Years 1901-1902. Bryozoa—Cheilostomata.

Major J. STEVENSON-HAMILTON, C.M.Z.S.

Notes on Albinism in the Common Reedbuck (*Cervicapra arundinum*), and on the Habits and Geographical Distribution of Sharpe's Steenbuck (*Raphiceros sharpei*).

The following papers have been received :—

FRANK E. BEDDARD, D.Sc., M.A., F.R.S., F.Z.S.

Contributions to the Anatomy and Systematic Arrangement of the Cestoidea.—X. On Two Species of Tapeworms from *Genetta dongolana*.

J. A. MILNE.

Pacific Salmon: an Attempt to evolve something of their History from an Examination of their Scales.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,
Secretary.

ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W.

April 15th, 1913.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

April 22nd, 1913.

E. T. NEWTON, Esq., F.R.S., in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

Mr. R. H. BURNE, M.A., F.Z.S., exhibited two pairs of deformed antlers of an Axis Deer (*Cervus axis*), lately presented to the Museum of the Royal College of Surgeons by Capt. Stanley S. Flower, F.Z.S. The deer was born in the Giza Zoological Gardens in 1899, the deformed antlers being shed in 1905 and 1906. The second pair showed a common malformation, *i. e.* duplicity of the brow tine, but the first pair suggested rather an injury during growth than a congenital malformation. At a similar point in each antler the beam was abruptly bent inwards upon itself at a very acute angle. The apical tines also were stunted, probably owing to an interference with the blood-supply brought about by the sharp bend in the beam.

Mr. E. G. BOULENGER, F.Z.S., Curator of Reptiles, exhibited a number of living specimens of the Leaf-Insect (*Phyllium crurifolium*), presented to the Society by Dr. Alfred Russell, which had been reared from eggs laid in captivity, and which showed various stages of development.

Dr. S. F. HARMER, F.R.S., F.Z.S., read a paper on "The Polyzoa of Waterworks." He gave some account of the serious trouble which had been caused by the occurrence of a rich and

* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of Sixpence, or, if desired, sent post-free for the sum of Six Shillings per annum, payable in advance.

varied fauna in the pipes of certain foreign waterworks, notably at Hamburg and Rotterdam. As was first shown by Kraepelin, the Polyzoa play a prominent part in the activity of the pipe-fauna, by feeding on Diatoms and other microscopic organisms, and serving in their turn as the food of other animals which prey on one another. The nutritive matter rendered available by the presence of enormous numbers of Polyzoa is thus in large measure responsible for the existence of other constituents of the fauna, which may include even fishes, such as the Eel and the Stickleback. The organic material supplied by the disintegration of the Polyzoa and other animals is believed to be important for the nutrition of Iron-Bacteria, which are well known to cause the most serious trouble in waterworks.

He then gave some account of five cases, which had recently come under his own observation, of the occurrence of Polyzoa in English waterworks in sufficient numbers to give rise to very serious inconvenience. In one or two of these cases the advice given by Kraepelin, in his paper on the Hamburg pipe-fauna, was being followed, by the introduction of a system of filtration, the principal object of which is to remove the microscopic organisms on which the Polyzoa, and ultimately the whole assemblage of animals in the pipes, depend for their nutriment.

The Polyzoa found in the five systems considered were referred to four species, and some account was given of the synonymy and distinguishing features of these. One of the species found was *Paludicella articulata* Ehrb., and the specimens were remarkable for the profusion with which hibernacula or winter-buds were being produced. The examination of the hibernacula resulted in the discovery of some evidence with regard to the mode of development of these structures—a subject on which no observations appear to have been hitherto published. The evidence recorded may have some bearing on the question whether there is any homology between the hibernacula of *Paludicella* and the statoblasts of Phylactolæmata.

A paper, communicated by Mr. CYRIL CROSSLAND, was received from Mr. A. W. WATERS, F.L.S., F.G.S., entitled "The Marine Fauna of British East Africa and Zanzibar, from Collections made by Cyril Crossland, M.A., B.Sc., F.Z.S., in the Years 1901–1902. Bryozoa—Cheilostomata."

In the collection dealt with from the neighbourhood of Zanzibar there are 76 species or varieties of Cheilostomatous Bryozoa, almost all being from 10 fathoms or under, so that for a shallow-water collection it is a very large one.

The nature of the articulation is traced in the Scrupocellaridæ from the simplest to the more differentiated forms, and Catenicellidæ with long nodes with many ovicells are described. The ovicells at the end of erect *Aetea* are again described. The author

says that our position at present is a very difficult one, as it is uncertain how much of recently proposed alteration of classification will be accepted. He considers that, while part of Levinsen's classification will no doubt be accepted, there will be modification in others, and he believes that in the future classification will be more based upon anatomical structures. The position and nature of the ovaria give some characters of value, but these characters require careful study to see how far they can be made available.

The fact is again emphasized that characters in one group or family are almost useless in the next, and all attempts at fixing certain characters as of primary importance and others of secondary lead to no result.

Major J. STEVENSON-HAMILTON, C.M.Z.S., Game Warden of the Transvaal, contributed a short paper recording the occurrence of albino examples of the Reed-buck (*Cervicapra arundinum*) in the Sabi Reserve, and containing some interesting notes on the habits and distribution of Sharpe's Steenbuck (*Raphiceros sharpei*), which resembles the Grysbok much more closely than it resembles the common Steenbuck in mode of life, and ranges from Nyasaland to the Transvaal, but gradually dies out to the south-east of that country.

The next Meeting of the Society for Scientific Business will be held on Tuesday, May 6th, 1913, at half-past Eight o'clock P.M., when the following communications will be made:—

EXHIBITIONS AND NOTICES.

FRANK E. BEDDARD, M.A., D.Sc., F.R.S., F.Z.S.

Contributions to the Anatomy and Systematic Arrangement of the Cestoidea.—X. On Two Species of Tapeworms from *Genetta dongolana*.

J. A. MILNE.

Pacific Salmon: an Attempt to evolve something of their History from an Examination of their Scales.

KATHLEEN HADDON.

Note on *Peripatoides woodwardii* Bouvier.

J. C. F. FRYER, M.A.

Field-Observations on the Enemies of Butterflies in Ceylon.

The following papers have been received :—

Dr. R. W. SHUFELDT, C.M.Z.S.

On the Patella in the Phalaenocoracidae.

Dr. R. BROOM, C.M.Z.S.

Observations on the South African Rhynchocephaloid Reptile *Euparkeria* and allied Genera.

P. CHALMERS MITCHELL, M.A., D.Sc., LL.D., F.R.S., F.Z.S.

Observations on the Anatomy of the Shoe-bill (*Balaeniceps rex*).

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,
Secretary.

ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W.
April 29th, 1913.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

May 6th, 1913.

Dr. HENRY WOODWARD, F.R.S., Vice-President, in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

Mr. E. G. BOULENGER, F.Z.S., Curator of Reptiles, exhibited a living melanistic specimen of the Green Lizard (*Lacerta viridis*) recently received from Dalmatia.

A new Species of Golden Mole.

Dr. R. BROOM, C.M.Z.S., exhibited an example of a new species of Golden Mole from near Springs, Transvaal, and described it as follows:—"Though closely allied to the Natal species, *Bematiscus villosus*, it differs in having a much softer fur of a dark reddish-brown colour, while the skull differs principally in having a temporal bulla almost half as large again as in *B. villosus*. For the new form the name *Bematiscus transvaalensis* is proposed. The following skull-measurements are given for comparison with those of *B. villosus* :—

	Length.	Breadth.	Dental Series.
" <i>B. villosus</i> , Smith's type	33	20·5	13·5 mm.
<i>B. villosus</i> , Dobson's specimen...	34	22	13 mm.
<i>B. transvaalensis</i>	34·5	23·5	14·5 mm."

Dr. Broom also exhibited an adult female of the large S. African Lizard, *Zonurus giganteus*, with two newly-born young, and three adult male specimens of the allied species *Pseudocordylus microlepidotus*.

* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of Sixpence, or, if desired, sent post-free for the sum of Six Shillings per annum, payable in advance.

Dr. F. E. BEDDARD, M.A., F.R.S., Prosector to the Society, read a paper on "The Anatomy and Systematic Arrangement of the Cestoidea." This paper, the tenth of the series, contained an account of two species of Tapeworms found in a Dongolan Genet, both of which were described as new, one being made the type of a new genus.

Mr. J. A. MILNE read a paper, communicated by the Secretary, on "Pacific Salmon: an Attempt to evolve something of their History from an Examination of their Scales," and illustrated his remarks with a large series of lantern-slides. Reasoning from the similarity of their appearance to the scales of the other Salmonidae, he pointed out that all the migratory species except *Onchorhynchus keta* remain for at least a year in fresh water before proceeding to the sea—in the Fraser River district, at any rate. He also showed the scale of a Quinnat, and pointed out that it was hardly possible to avoid the conclusion that that fish had already spawned once before it was captured. The ages, and lengths of the different fishes at varying ages, were also dealt with in the paper.

A paper, communicated by Prof. J. STANLEY GARDINER, M.A., F.R.S., F.Z.S., was received from Miss KATHLEEN HADDON, containing some notes on *Peripatoides woodwardii* Bouvier.

This paper was based on material collected in Western Australia, consisting of twenty specimens, male and female, ranging in size from 17 to 46 mm., thus considerably exceeding in length those described by Prof. Bouvier. Various types of coloration are exemplified, some being blue-green with small yellow spots, while others have the yellow pigment increased so as to give a tawny appearance to the animal; a dark variety of this latter type also occurs.

Peripatoides woodwardii is characterised by the possession of sixteen pairs of legs, and coxal glands are present in the male in all except the 4th, 5th, and 15th pairs. The female has a receptaculum seminis on each oviduct shortly after its emergence from the ovary.

Mr. J. C. F. FRYER, M.A., gave a brief account of some field-observations on the enemies of butterflies in Ceylon. During a residence of nearly two years in this island the more common insectivorous birds were watched almost daily. Excluding the depredations of the Wood-Swallow (*Artamus fuscus* Vieill.), thirty attacks on butterflies were noted, of which thirteen were successful. In five of the successes the butterfly was flying badly. Two attacks were made on insects supposed to be relatively distasteful, and three on the mimetic females of *Papilio polytes* Linn. The Wood-Swallow lived almost entirely on butterflies and confined itself, with few exceptions, to members of the Euploëinæ and

Danainæ, insects usually considered distasteful. Asilid Diptera killed butterflies indiscriminately. It was concluded :—

- i. That in Ceylon, with the exception of the Wood-Swallow, birds are not formidable enemies to butterflies;
 - ii. That owing to the propensity of the Wood-Swallow for members of the genera *Danais* and *Euploea*, a resemblance to them would be not a safeguard but a danger.
-

The next Meeting of the Society for Scientific Business will be held on Tuesday, May 20th, 1913, at half-past Eight o'clock P.M., when the following communications will be made :—

EXHIBITIONS AND NOTICES.

The Rev. T. R. R. STEBBING, M.A., F.R.S., F.Z.S.

Notice of some important works on Zoological Nomenclature now in progress.

Dr. R. BROOM, C.M.Z.S.

Observations on the South African Rhynchocephaloid Reptile *Euparkeria* and allied Genera.

E. G. BOULENGER, F.Z.S.

Experiments on the Metamorphosis of the Axolotl (*Amblystoma tigrinum*) conducted in the Society's Gardens.

G. E. BULLEN.

On some cases of Blindness in Marine Fishes.

Dr. R. W. SHUFELDT, C.M.Z.S.

On the Patella in the Phalacrocoracidae.

The following papers will be taken at the Scientific Meeting on June 3rd, 1913, which closes the session :—

Sir ARTHUR H. CHURCH, K.C.V.O., M.A., D.Sc., F.R.S., F.S.A.

Notes on Turacin and Turacin-bearers.

Surgeon JOSEPH C. THOMPSON, U.S.N.

Contributions to the Anatomy of the Ophidia.

Prof. T. WINGATE TODD, M.B., F.R.C.S.

Observations on Osteomalacia in the Zoological Collections of
Manchester and Cleveland.

T. H. WITHERS, F.G.S.

Some Miocene Cirripedes of the Genera *Hexelasma* and
Scalpellum from New Zealand.

P. CHALMERS MITCHELL, M.A., D.Sc., LL.D., F.R.S., F.Z.S.

Observations on the Anatomy of the Shoe-bill (*Balaeniceps*
rex).

Communications intended for the Scientific Meetings should
be addressed to

P. CHALMERS MITCHELL,
Secretary.

ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W.

May 13th, 1913.

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NOTICE.

The 'Proceedings' for the year are issued in four parts, paged consecutively, so that the complete reference is now P. Z. S. 1913, p. . . . The Distribution is as follows:—

Part I. issued in March.

" II. " June.

" III. " September.

" IV. " December.

"Proceedings," 1913, Part I. (pp. 1-152), were published on
March 7th, 1913.

The Abstracts of the 'Proceedings,' Nos. 117-121, are
contained in this Part.

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